American Machinist

A McGRAW-HILL PUBLICATION

June 16, 1937

It's hard to find a plant modern in every detail, but few manufacturing set-ups will qualify better than those employed by I.B.M.

ANNUAL MODERN PLANT NUMBER

describing the management and manufacturing methods of

INTERNATIONAL BUSINESS MACHINES CORPORATION

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Presenting

the ANNUAL MODERN PLANT NUMBER of AMERICAN MACHINIST

. . . a detailed story of the manufacturing establishment of International Business Machines Corporation . . . . one of Industry's most distinguished successes.

Every year American Machinist publishes this Modern Plant Number, because its readers are vitally interested in seeing how certain plants which have made outstanding achievement in manufacturing are able to do it . . . . management policies, labor relations, manufacturing methods, equipment.

American Machinist distinctly avoids presenting a mere "romance of success" story . . . . instead presents a careful description of what the manufacturing establishment is and how it operates. Both editorial and advertising pages are packed with specific information of practical value to every metal-working executive.

The management of International Business Machines Corporation has generously co-operated in opening its plant to the expert study of American Machinist editors, who have combed it for the significant facts which have actual value to their readers.

American Machinist considers it a privilege to present this exclusive story of International Business Machines Corporation, and publicly thanks every member of that organization who co-operated in making it possible.

AMERICAN MACHINIST

JUNE 16, 1937

THE MACHINES OF BUSINESS

OUR present advanced civilization is based upon the more and more refined use, and the wider and more complex application, of the relatively few prime materials with which nature supplies us. Only the invention of machinery has made this progress possible. Many of the things we enjoy, and even more of those we regard as necessities, would not be here today if it were not for the machines that are responsible for their production. These machines represent the heavy artillery in the front line of our battle to wrest an ever better and better life from the earth on which we live.

The more involved our methods become, the more difficult also becomes the control of our operations. If we want to accomplish, we have to know. It does not require a mathematician to figure out that an army of millions would be needed to gather the requisite facts for this knowledge, and almost as large a one to put them into statistical form to make them usable. So another line of machines has been created that might be likened to the staff troops of our mechanized army of peace. This is the line of business machines, the intricate devices that rid our offices of much clerical drudgery, just as the production machines have removed most of the physical effort of the manual worker.

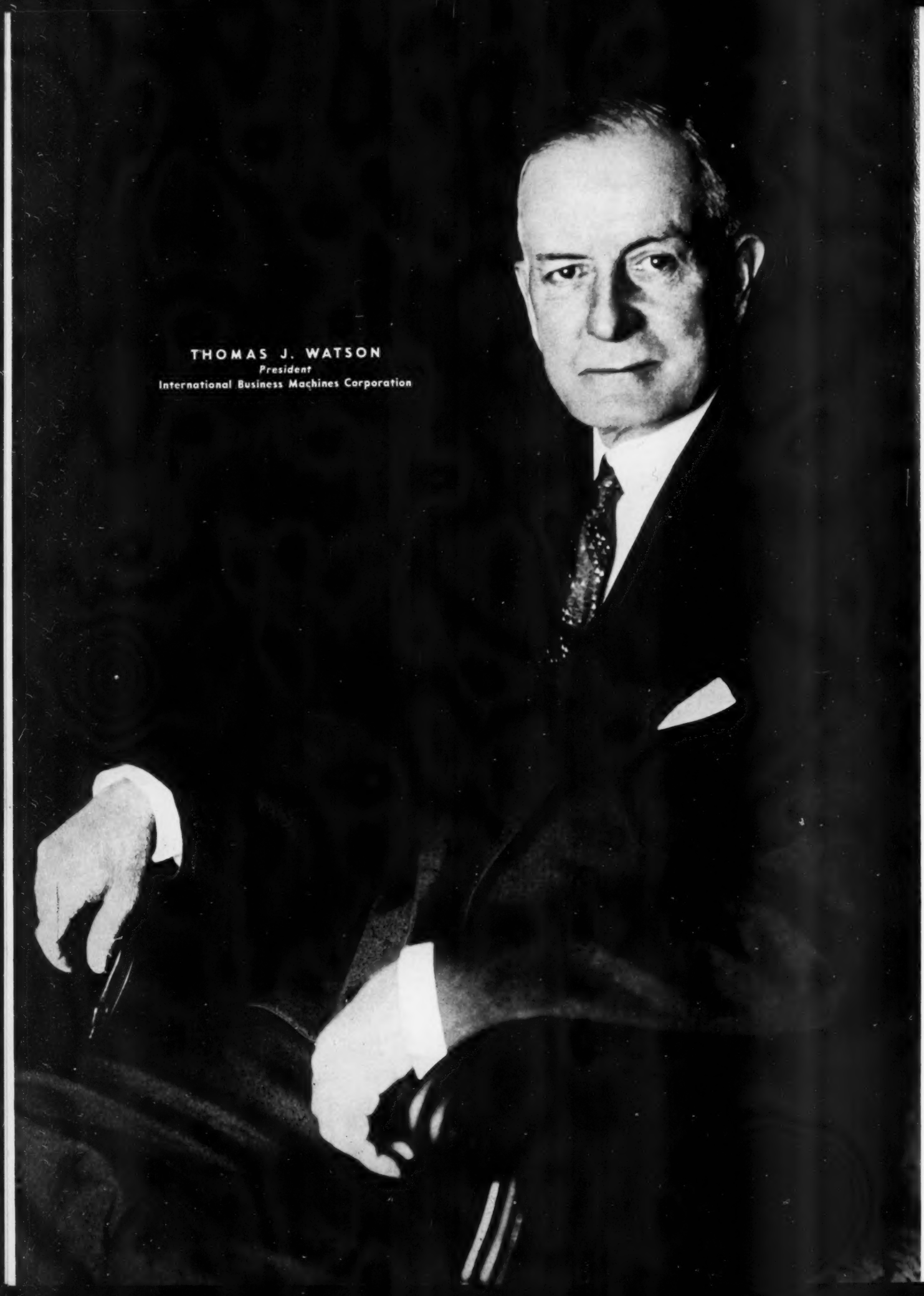
It is our privilege in this number of American Machinist to describe the organization, methods and equipment of a corporation that has made an outstanding success in the manufacture and distribution of business machines.

Much has been written about the sales methods of the International Business Machines Corporation, and about the educational work that has contributed so much to its success. Little has been said about the manufacturing methods that are responsible for its various products, and there is much to be said, because they are quite as outstanding as anything else about this enterprise.

In our annual Modern Plant Number of last year, we described the production of automobiles, a typical large lot operation. By contrast this number tells about a small lot operation carried on under unusually good working conditions, on equipment well above the average, and with policies that rival any that the editors have ever encountered.

It has been a fascinating job to study I. B. M. manufacturing. We trust that this I. B. M. Number will do it justice.

THE EDITORS.



THOMAS J. WATSON
President
International Business Machines Corporation

FROM INVENTOR'S SHOP TO INTERNATIONAL CORPORATION

The International Business Machines Corporation owes its success to management that has insisted on the best of factory equipment, tireless research and invention, and intensive development of its manpower in sales, engineering and production activities

HALF A CENTURY ago business, industry and engineering were just starting the amazing development which has brought us to the standards of living we enjoy today. Business records were about to emerge from the letter press stage, industry was just beginning the application of power through manufacturing processes which is largely responsible for the high wage levels of our progressive companies as we know them, and engineering was turning from land surveying and railroad building to the development of the machines without which our civilization would not exist.

EARLY INVENTIONS

In 1888, Willard L. Bundy, a jeweler of Auburn, N. Y., patented his invention of a mechanism for "in" and "out" registrations of employees' time attendance. This "key" time recorder and the first dial recorder, invented at the same time by Dr. Alexander Dey, a Scottish physician, were the forerunners of the present-day line of International time recorders and electric time systems.

During that same period in the Eighties, Dr. Herman Hollerith, a statistician in the United States Census Bureau, was developing a mechanical method of tabulating census data. By his system, data were transcribed to paper strips (now cards) by means of punched holes, which would then actuate an automatic tabulating machine by a simple electromagnetic principle. The successful application of the method to vital statistics, to the United States Census of 1890 and foreign censuses, to transportation and commodity statistics, indicated subsequent industrial and social applications. Dr. Hollerith's pioneer tabulating equipment was the predecessor of the modern line of International electric bookkeeping and accounting machines which are used today throughout the world by business and industry, finance and governments, institutions and social agencies.

Meanwhile, during the same early period of the tabulating machine and the time recorder, the first computing scale, invented by Julius E. Pitrat of Gallipolis, Ohio, was being developed for manufacture and marketing by Edward Canby and Orange O. Ozias. The Dayton Scale Division which resulted was one of the pioneer companies that formed the consolidation now known as International Business Machines Corporation. In 1934, this division was sold to the Hobart Manufacturing Company in order to concentrate along the natural lines of service to industry generally. Important principles of the computing scale are embodied, however, in the company's present line of industrial scales and counting devices.

To go back to the early days: Manufacturing of time recorders was started in Binghamton, N. Y., moving to Endicott, site of the present main plant, in 1907. Among the organizers of the pioneer time recorder company was A. Ward Ford, who is today a director of International Business Machines Corporation. The first tabulating machine shop and laboratory were contained in a small building on the Chesapeake & Ohio Canal in Washington, D. C., where Otto E. Braitmayer, now vice president and a director, was a youthful assistant to Dr. Hollerith. The first computing scales were manufactured in a little frame shop in the rear of the Callahan Power Building on Main Street in Dayton, and Samuel M. Hastings, also a director today, formed the first sales agency.

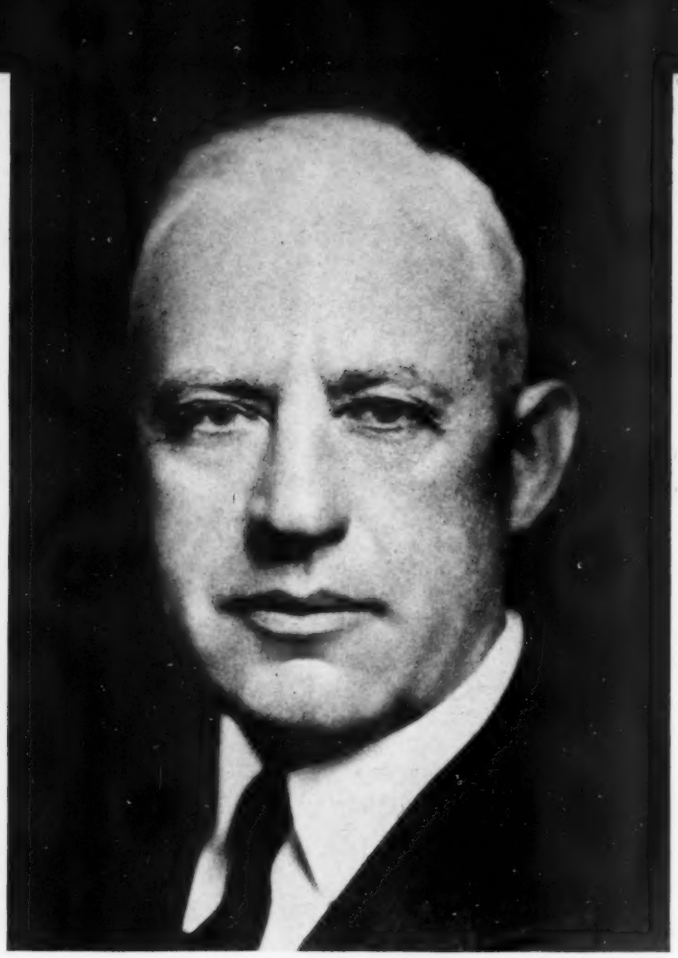
These three companies went their separate ways until June 16, 1911, when the Computing Tabulating Recording Company was incorporated as a holding company to take over ownership of the three parent concerns. Charles R. Flint had been convinced that a merger of the three companies, each of which was producing what was in effect a single essential part in what should be a complete service—the measurement of materials, the measurement of working time, and the organization of the facts obtained by this measurement—was not only logical, but would result in a business institution entitled to rank among the foremost in the world. He approached all three companies with proposals for a merger and gained acceptance.

The task of bringing together three different and formerly distinct business organizations is always a difficult one, however logical from every point of view the consolidation may be. The board of directors of the new company fully realized this. They therefore sought an outstanding executive and leader, not previously identified with any of the component companies, to weld them impartially into a harmonious unit.

THE MAN FOR THE JOB

In 1914, they found him in the person of Thos. J. Watson. Mr. Watson had had long, thorough and successful experience as a sales builder and executive in the field of specialty manufacturing and business service, dealing with problems not unlike those confronting the new company. He brought to his job a belief in the future of the company, and certain policies for building it to that point. He also brought with him a young

FREDERICK W. NICHOL
Vice President and General Manager



OTTO E. BRAITMEYER
Vice President

man, Frederick W. Nichol, who served as his secretary and has since risen to the position of vice president and general manager.

In a talk before a convention of employees of the company that numbered 235 members in 1915, Mr. Watson said: "We have to deal with just one thing throughout the whole organization—MAN." And since the "power" in "manpower" is derived from man's power of thought, he instituted as the company's watchword the single word: THINK. Then came an educational system, which included courses for all members of the organization, in order to teach them to think, to know their own jobs thoroughly, to enlarge their opportunities, and to better the company's service. Mr. Nichol's rise from his stenographic notebook, the advancement of Walter F. Titus from the ranks as a serviceman to a vice presidency, and the success stories of other executives show the effectiveness of Mr. Watson's "man-growing" program.

Education would take care of the development of men. The next major objective was the development of machines. Confronted with a situation wherein no provision was being made for meeting future demands, without any engineering or development work being done, Mr. Watson warned: "We cannot stand still on development work; we must get out new things—things not in the minds of any of us here today." With this inescapable fact in mind, he established a vigorous program of research and engineering development, enlisting the best inventive brains and engineering ability in that field that could be obtained, authorizing expenditures that in the light of subsequent expansion and entries into new and until then unthought-of markets have proved their wisdom.

SALES ORGANIZATION

In addition to his recognition of the necessity of developing men and products, respectively through education and engineering, Mr. Watson brought to the company talents for energizing and building a sales organization. Education would equip the men mentally, would give them the knowledge and the consequent enthusiasm to present their message of business service, and would enable them to deliver the results promised. Convinced of the effectiveness of getting men to exchange ideas, methods, policies and plans, he immediately began to bring the members of the organization together in conventions, sales meetings, executive schools and managers' conferences, and the result was a clearer definition in all minds of the aims and policies of the company. Individual territories were assigned, thus protecting the sales representatives; a quota system was established that was fair to the company and to the salesmen alike; sales contests were inaugurated to challenge the competitive spirit that is ever present in salesmen; their achievements were publicized in the company's house organ; and an organization of sales leaders, composed of those who made quota for the year, was founded with a convention given in their honor at which they received tangible awards.

This activity was not confined to the United States. Mr. Watson saw the world as a market for the service of his company's products. He devoted himself on an international front to the building up of foreign markets, visiting country after country, studying markets and industries, energizing and coordinating a world wide organization. The international expansion of the company by 1924 justified the change of name that year to International Business Machines Corporation.

Directly tied in with the expansion of markets was, of course, the enlargement of manufacturing facili-

WALTER F. TITUS
Vice President

ties. From the first, Mr. Watson has been an advocate of utilizing the most modern and efficient manufacturing equipment, recognizing its importance in the production of what are essentially quality devices.

Manufacturing expansion and the opening of new factories have resulted in modern industrial plants in Endicott; Washington, D. C.; Rochester, N. Y.; Dayton, O., Toronto, Canada; London, England; Paris, France; Berlin and Sindelfingen, Germany; and Milan, Italy.

Also instrumental in building the business has been the policy in which the interests of the employees are taken into consideration. Insurance, health and safety measures, recognition of veteran service, recreational facilities, two weeks vacation with pay for factory and other employees with one year of service, and one week for employees having 6 months' service, homes at cost for Endicott employees, and other provisions for employees' welfare, are evidence of the cooperative relationship between management and employees in International Business Machines Corporation.

During the depression years that followed 1929, International Business Machines Corporation demonstrated its adaptability for "rough weather" sailing. Aggressive policies continued in force—in machine development, in increasing and training manpower, in market expansion—with the result that the company maintained its progress. It is significant that in the years since 1929 fourteen new countries were entered, bringing the distribution of products up to seventy-nine different countries; many new and improved machines were brought out, opening wholly new markets and extending applications; the company entered the writing machine field, acquiring its all-electric typewriter and writing machine line which it has improved and developed since the purchase of Electromatic Typewriters, Inc., in 1933. The Endicott and Paris plants were courageously enlarged during this period; the company's schoolhouse and engineering laboratory at Endicott were built; new plants were opened in Berlin and Milan; new branch offices, showrooms, and service stations were established throughout the world; personnel was increased by 58 per cent and more people trained in company schools than during any other like period in the company's history; and a new building was bought at 57th Street and Madison Avenue in New York City where the company's world headquarters will be located. (European headquarters are in Geneva, Switzerland, and South American headquarters are in Buenos Aires, Argentina.)

The company's expansion in the face of troubled times when many other companies were retrenching was a testimonial of confidence in the future of the world of business and the company's service. Mr. Watson believes in the future of civilization and of economic growth that goes hand in hand with true progress. That confidence is founded upon his company's watchword, THINK. He believes that real progress is being realized in getting people to think things out and to act on the basis of constructive thought.

Electric bookkeeping and accounting machines

Electric time recorders and systems

Ticketographs

PRODUCTS

No story of production processes would be complete without some word about the products themselves, what they do, and where they do it. I.B.M. products have spread beyond the fields of the three constituent companies, as is outlined

OUT OF THE pioneer inventions back in the Eighties—inventions of the time recorder, the Hollerith tabulating method, and the computing scale—and as the result of an incessant program in the company's engineering laboratories to improve, refine and develop new machines and methods in the years since 1914, there has grown a line of products that extend throughout the whole range of business and industrial management, and influence governmental functions, institutional and scientific research, and social agencies.

International business machines and service are grouped under the following main classifications:

International Electric Bookkeeping and Accounting Machines
International Business Machines Service Bureau
International Time Recorders and Electric Time Systems
International Electric Writing Machines
International Industrial Scales and Counting Devices
International Proof Machine for Banks
International Ticketographs
International Protective Devices
International Sound Distribution Systems
International Filene-Finlay Translator Equipment
International Test Scoring Machine

The basis of the International electric bookkeeping and accounting machine method is the tabulating card on which all recorded information is represented by punched holes. The devices used for electric accounting work may be divided into three major classes: (1) punching machines that record the information in the cards; (2) electric card-operated sorting machines that sort the cards into accounting groups; (3) various machines for obtaining the final results. Among this group are the electric bookkeeping and accounting machine of the numerical type; the alphabetic accounting machine that handles both alphabetic and numerical data; the direct subtraction accounting machine; the automatic multiplying punch; the invoicing tabulator; etc.

The company maintains tabulating service bureaus in principal cities. Through these bureaus the advantages of the punched card method are made available at a reasonable cost on a time or volume basis.

International time recorders and electric time systems are used widely by every kind of business, industrial organization and institution throughout the world—wherever time is indicated, measured or recorded. Among the many devices that may be operated either individually or as units in a completely self-regulated electric system are: automatic payroll machines; attendance time recorders (dial, card and autograph); job time recorders; time stamps; wall clocks; time flashers; master clocks; tower and outside clocks; automatic program signaling machines; athletic timing equipment; recording door locks; watchmen's patrol systems, etc.

Every movement of International electric writing machines is actuated by electrical power. A slight pressure on the keys makes the electrical contact that results in the operation of the machine. Carriage return, type seg-

OF I. B. M.

ment shift, tabulator, typebars, backspacer and escapement are electrically powered. Smooth typing rhythm results. Tests have shown the features of the all-electric writing machine to be increased production, evenness of impression, less fatigue on the part of the operator, and the ability to produce as many as twenty carbon copies at one typing. Among International electric writing machines are the all-electric typewriter; an all-electric forms-writing machine for handling all types of manifold work; and a front-feed all-electric correspondence machine.

The International line of industrial scales and counting devices includes automatic scales for counting parts, pieces and various units of measurement; heavy duty scales; bench scales; parcel post and mailing scales; and many other types used for special purposes—such as packaging, measuring textile fabrics, computing the percentage of weighting in fabrics, testing and checking. One of the outstanding devices in this group is the accounting scale. It is the only automatic counting scale that indicates in figures on a chart the number of pieces in the load. These scales and counting devices protect business from unnecessary losses due to over- or under-weight; guard against waste; protect the quality standard of products and provide accurate figures for material accounting.

The International proof machine for banks is used to list, sort and prove checks in the receiving tellers', mail tellers' and bookkeeping departments of banks. In a single operation, this machine accomplishes what formerly required three separate steps. It sorts and lists checks according to banks, totalizes checks by banks, and proves all checks against deposit slips.

International ticketographs are used to maintain predetermined cost schedules under the coupon-method of wage payment; to control payroll and to control production. The ticketograph system is founded on work tickets comprised of coupons arranged in operation sequence. By means of the ticketograph, the prices which are to be paid on a given lot are simultaneously printed on a given set of coupons together with other pertinent information. As the work progresses, the workers remove their respective coupons and present them as vouchers for pay.

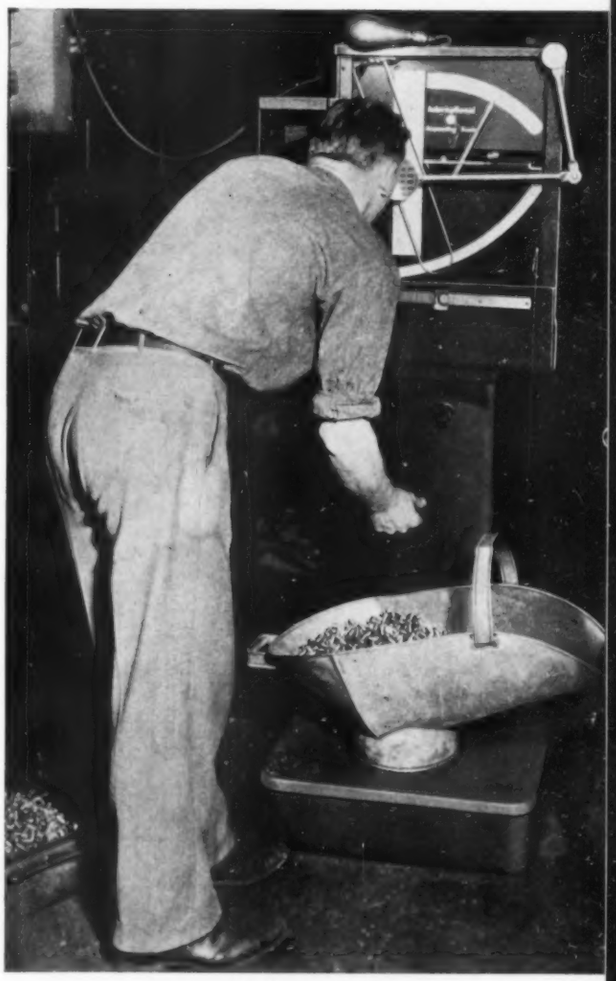
Among International protective devices is the Recordolock which gives a private, easy-to-read, printed record of who locked or unlocked the door; the time to the minute when the locking or unlocking occurred; whether the locking was done from the inside or outside; whether all openings were securely fastened; and the time of the supervisor's visits or watchman's rounds. The International watchclock system consists of a portable recorder and stationary registering stations. Its purpose is to insure systematic, regular patrol of protected property. The recorder is carried to each station where an embossed tamper-proof record is made of the visit.

International sound distribution systems provide for the controlled amplifications and distribution of radio, microphone and phonograph programs. All three sources of sound are centralized in one easily operated instrument.

The International Filene-Finlay translator system permits international conferences to proceed with as much ease as a gathering where everyone speaks the same language. Each system is equipped with sets of headphones having selector devices, by means of which delegates may "listen in" in any language desired. Each member of the audience may without interference select the language he wishes.

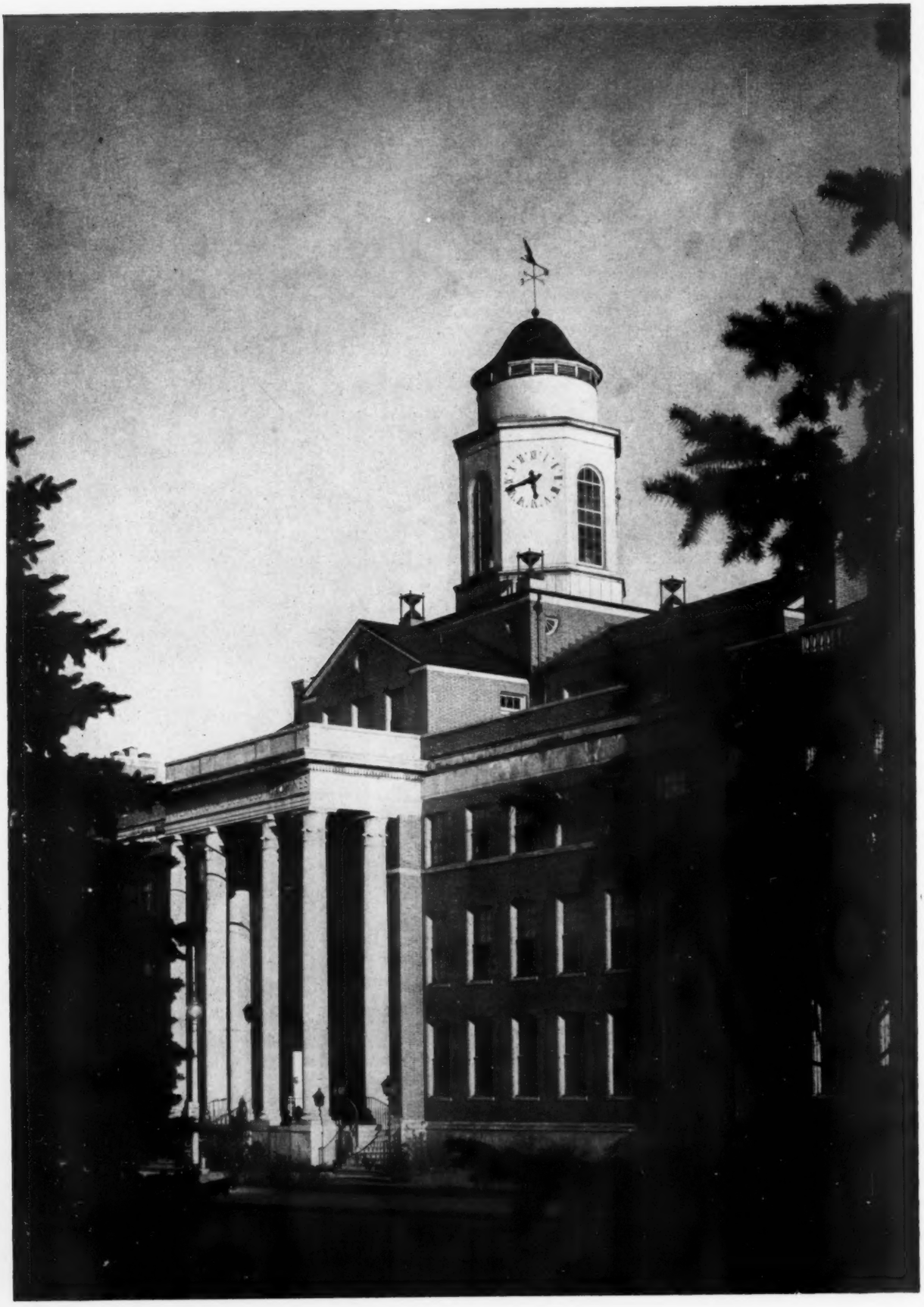
The International test scoring machine is used in grading objective examinations of the true-false or multiple choice type, automatically scoring the results. The machine will also calculate weighted averages.

Electric writing machines



Industrial scales and counting devices

Proof machines for banks



EACH PROJECT ENGINEER *has his own drafting room and group of assistants*

ENGINEERING AT ENDICOTT

I. B. M. engineering is a production function and reports to the manufacturing vice president through his engineering assistant. It is housed in an air-conditioned building and is provided with every conceivable facility for efficient operation

ENGINEERING at Endicott functions in surroundings as nearly perfect as can well be imagined. The engineering laboratory building is a colonial brick structure, air-conditioned throughout, and connected to the other buildings by a tunnel. Laboratories occupy the basement floor. A reception room, known as the Hall of Products, and the manufacturing engineering department take up most of the first floor, and the upper floors are broken up into invention departments or suites, each with its director's office, a drafting room and a model room equipped with a few simple machine tools. There is a well equipped research library in the pent house, and a music room for the various musical organizations as well.

WHERE NEW MODELS START

New and improved models of the corporations products are made ready here for introduction into the manufacturing departments. Lines of authority and responsibility are clearly drawn for the various divisions but they are no barriers to the general spirit of cooperation that pervades the whole organization.

Research, adequately equipped and well staffed, deals with immediate product problems rather than fundamental investigation. In the chemical laboratory routine analytical determinations are made and some work is done for local hospital and civic needs. The electrical laboratory passes on all electrical features of the various products in projects and carries on research work for electrical

A PRIVATE MODEL ROOM *is also a feature of each project engineer's suite*

improvement. The metallurgical laboratory carries on photomicrographic and spectographic studies of ferrous and non-ferrous materials. The paper testing laboratory tests and investigates paper for the cards without which the tabulating machines could not function. The time center controls the electric clocks throughout the big plant.

RESEARCH IN THE FIELD

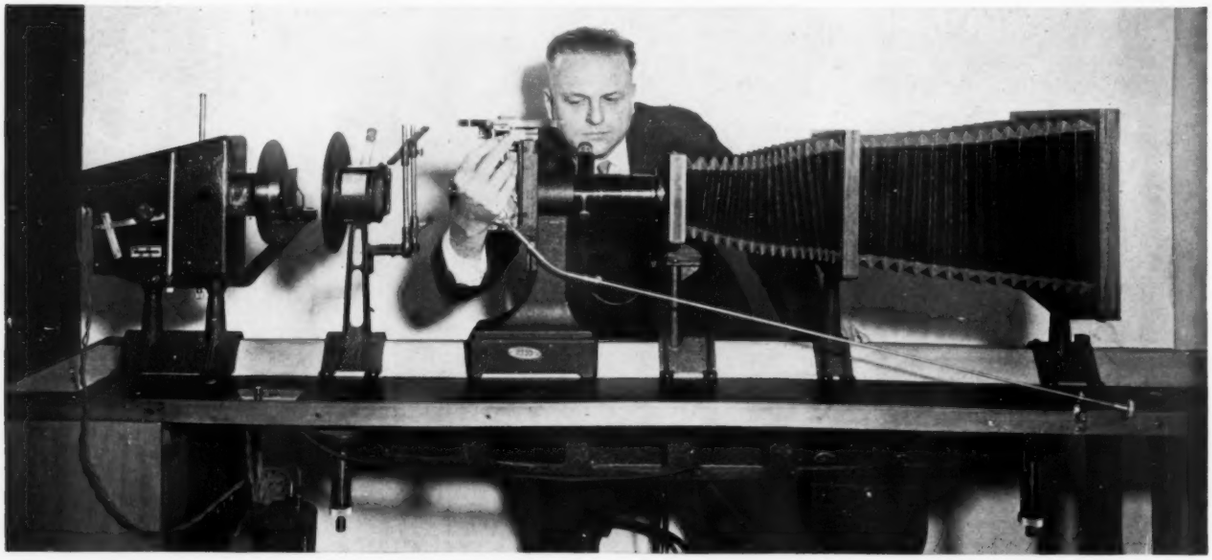
Generally speaking, ideas for new products, and suggestions for improvements to existing ones, originate in the field and are developed in the engineering laboratory, but there are exceptions, of course. The customer research department has 15 to 20 men in the field constantly looking for new ideas, quizzing customers on their requirements and looking for new outlets.

When a new idea has taken form sufficiently to permit specifications to be drawn up, these specifications are placed before the Future Demands Committee in New York. If they are approved, they go back to Endicott and are assigned to the project engineer best fitted to develop them. It may take him a year or it may take him six years, but eventually he produces a layout of a machine that will meet the requirements, or he reports that the obstacles are too great to overcome within the limits of cost specified.

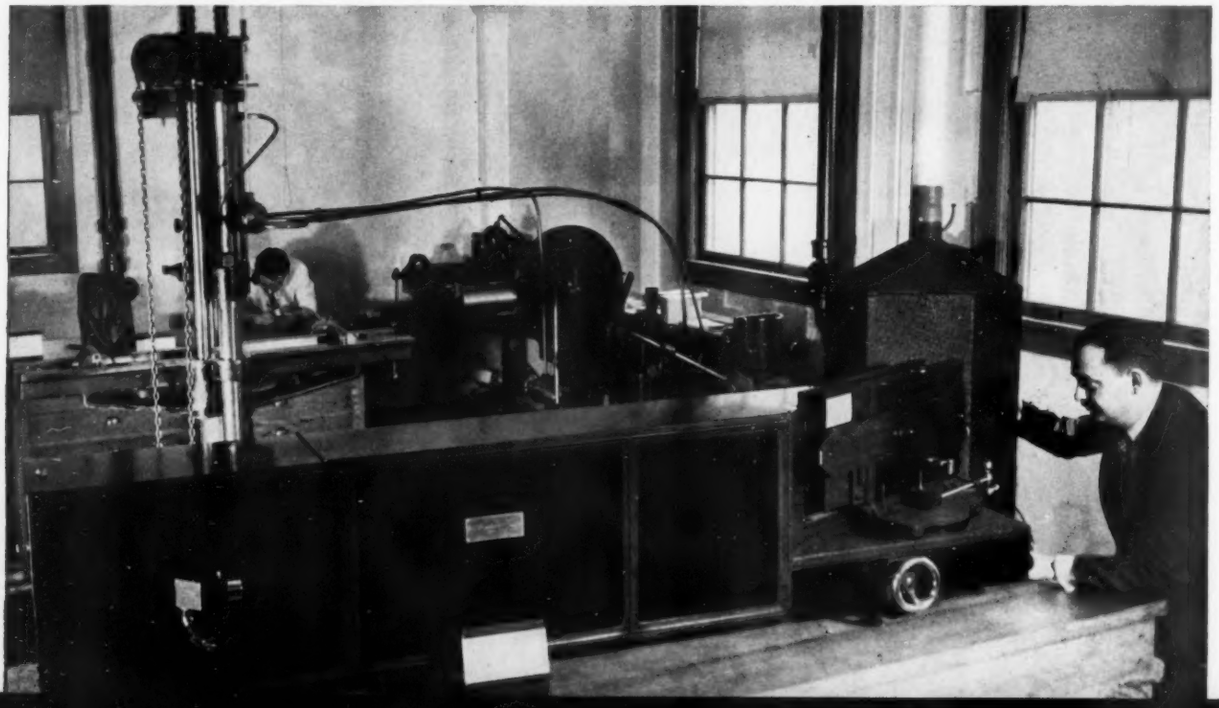
His layout goes to a conference where he presents it to the manufacturing vice president, the chief engineer, the field research man who fathered the suggestion and the manufacturing engineer. If he gets it past this group he starts on a model. Parts are ordered from the factory where they are usually made in a special machine shop in which single parts and attachments for customers are built. The parts are assembled and fitted in his own model room.

LOOKING FOR TROUBLE

If the model functions satisfactorily the patent department goes over it for legal snags, and the manufacturing engineer tackles it from the production viewpoint. The project engineer's job is to construct a model that will function regardless of manufacturing difficulties. Compromises with the manufacturing problems come later. Checking lay-



THE METALLURGICAL MICROSCOPE *shown above is an indispensable tool of the metallurgical laboratory*



OF EQUAL VALUE FOR TESTING *operations and research work is the spectrograph illustrated below*

FIRST CLASS EQUIPMENT *and a model switchboard distinguish the electrical laboratory*

IN ONE CORNER *of the air-conditioned paper test laboratory is this device for testing paper stiffness*

outs are made in the manufacturing engineering department, and if no troubles loom up the job is tooled for production. If trouble is anticipated a production model is built, or if possible a pilot lot of 10 to 25 machines. One goes to the testing department for a breakdown test while the others go into the field for test under the eyes of field research men. The engineer often goes into the field with a model himself.

All through the development proeess the metallurgical and electrical specialists are consulted whenever a problem in their respective provinces bobs up. The director of research is responsible for material standards, and no materials go into production without his approval.

300 ENGINEERS

In the engineering department there are nearly 300 engineers, perhaps 100 of them on active development work. In the field are customer service men about half of whom devote their time to developing special machines and attachments to meet customer requirements, the other half working as trouble shooters. When changes are recommended by the trouble shooters their needs get priority through the manufacturing engineering department, and the shop.

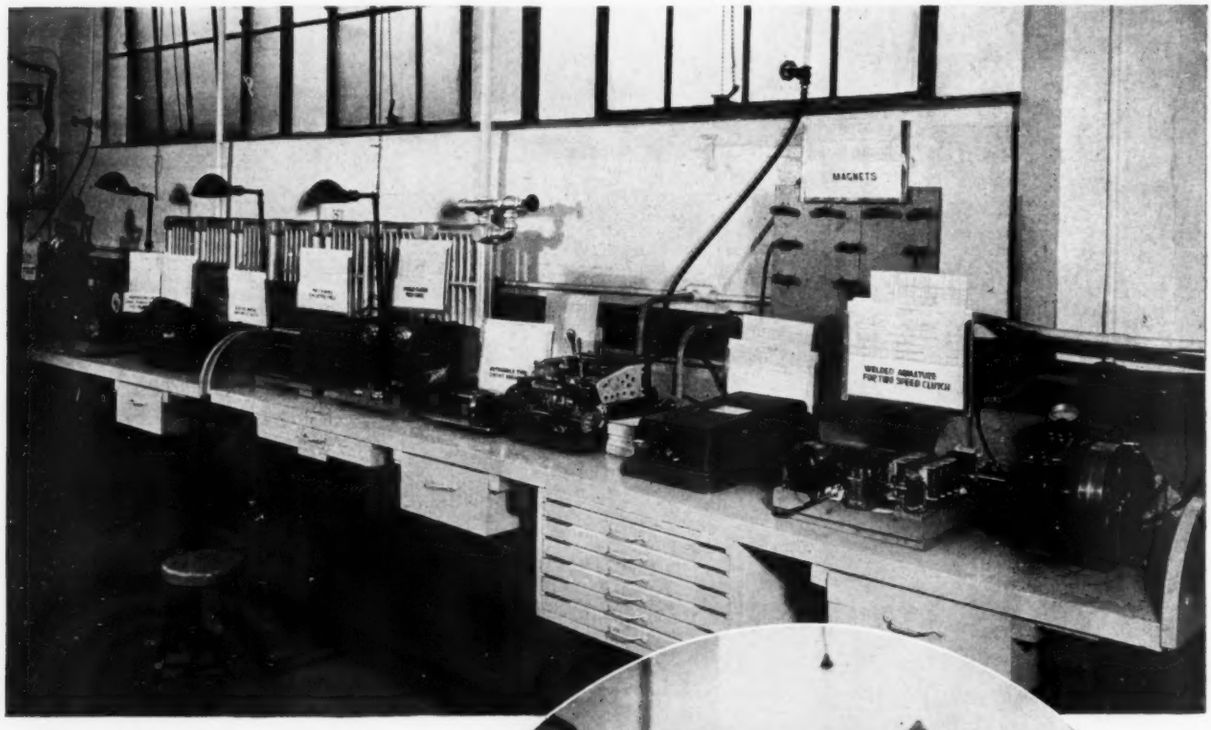
To supply recruits for the engineering divisions the chief engineer and some one of his associates look over the graduating classes in a number of engineering schools each year and select from 8 to 20 likely candidates. These men are put through a two-year training course in the factory and laboratories. They work on the machines in all departments and the foremen see to it that they learn about any unusual job that may be on some other machine. In addition they are allowed one day a week to observe factory methods. When they finish they may be assigned to sales, service, engineering or the factory, depending on the aptitude they have shown. During their training period they get courses in manufacturing analysis, metallurgy and design, and they are assigned regular problems in product and tool design. As they progress they are watched hopefully for signs of originality, and they are encouraged to make suggestions for improvement in anything they see.

The testing department, referred to earlier, reports to the field service

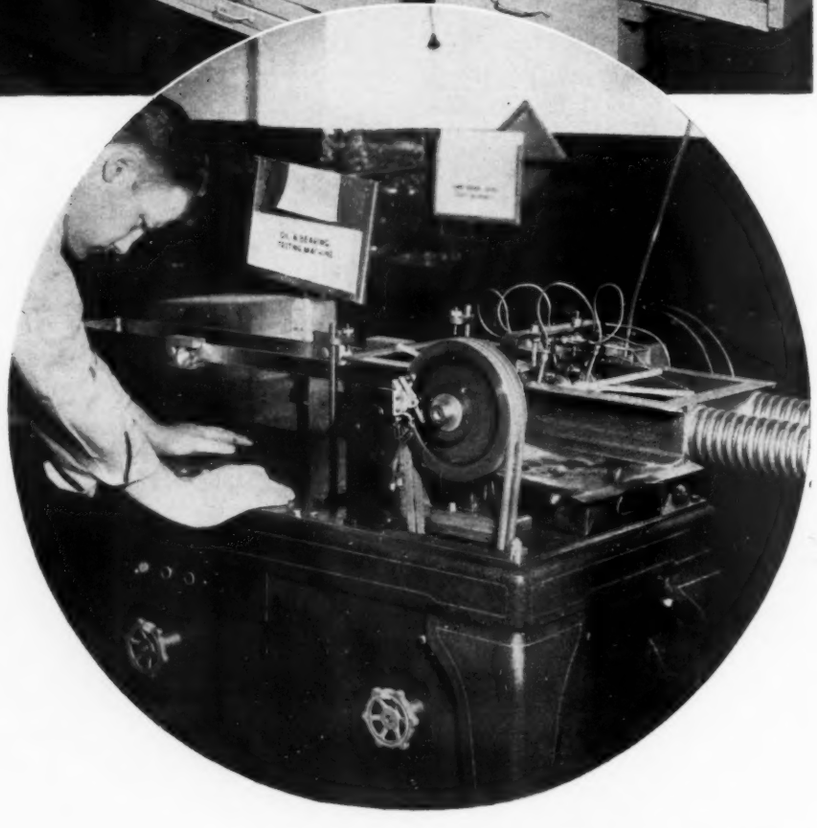
division and looks at new or improved models from the customer's viewpoint. Simulating field conditions as closely as possible it checks the functioning of complete machines or individual parts to find how well they work and how long they will last. It is interested also in accessibility for the operator and for the service man. Its three shifts of mechanics and clerks operate 24 hours a day to accelerate testing as much as possible.

Complete models are checked for satisfactory performance under reduced voltage, under increased voltage, at speeds 50 per cent above normal, at speeds down to zero, under extreme temperature changes, under salt spray if the destination is the tropics. If a part looks weak a bench robot is devised to subject it to an accelerated breakdown test.

With a few exceptions the testing department is not concerned with comparative tests. Its job is to make sure that the machines designed by the engineers and built in the factory do what is expected of them in the hands of the customer.



BENCH ROBOTS *these home made testing units are called. They do accelerated destruction tests on all sorts of parts and units*



BOTH OILS AND BEARINGS *are tested in this machine which can take four cylindrical bearings at once. All oils used by I.B.M. are sample tested here*

The Schoolhouse at Endicott

EDUCATION FOR ALL

1600 people, men and women, supervisors and machine hands, engineers and apprentices, were enrolled last winter in 24 different courses at the I.B.M. school

WHEN reference is made to the Dean of the I. B. M. School at Endicott, the first reaction is one of surprise, but when the whole I. B. M. educational program is explained it is easy to see that the job of Dean is considerably more complicated than that of many college deans, and involves direction of many more students. Nearly half of all the factory people employed at Endicott attend classes in the I. B. M. Schoolhouse. To be specific, 1600 out of the total of 3800 factory employees are enrolled in 52 different classes, studying 24 subjects.

In addition to the 1600 factory employees just mentioned, and the student engineers referred to in the article on the engineering department, a large number of students are enrolled in the various sales, customers' service, systems service and apprentice schools. Together they make up a very impresisve student body.

Each year about 500 young men and women are hired by the personnel department for work in the factory and offices. Perhaps 50 out of the 500 are assigned to clerical positions in the offices. So far as possible, these new employees are hired from among the residents of Endicott, Johnson City and Binghamton, and therefore live within a ten- or twelve-mile radius of the factory. They range in age from 18 to 35 and, in general, have at least a high-school education. The policy of the company is to train these new employees through its educational facilities and thus fit them for more responsible jobs. Enrollment in the factory school classes is not compulsory. Frequently, men from the factory are promoted to positions in the engineering, service or sales departments, or to the office force.

MOTION STUDY LOOPS

Here is an example of the interest in educational advantages shown by a group of factory employees. A series of motion analysis moving pictures was taken in the drilling department, and, after some study, the best method of performing several operations was determined and transferred to a loop of motion picture film. This loop was run through a projector repeatedly for the benefit of the observers so that they might get the sequence of operations firmly in mind. Most of the men of the drilling department attended classes at which these loops were shown. As a result, the overall efficiency of the department rose 7 per cent.

Courses in blueprint reading, shop mathematics, and measuring instruments offer possibilities for increasing the employees' knowledge of manufacturing and familiarity with the language of the shop. Departmental courses in modern milling practice and modern grinding practice are also offered. Employees in the assembly departments may take the courses already mentioned as well as additional courses in electricity, which serve as basis for a better understanding of the accounting machines manufactured by the company.

For the benefit of employees in the engineering laboratories and in the manufacturing and production engineering departments courses are offered in manufacturing analysis, heat-treatment, and the like.

Classes for factory employees continue for a period of 36 weeks and meet at 5 o'clock and at 7 o'clock on the five workday evenings. As a general rule, a particular class section meets only once a week. Students in these classes are expected to spend several hours a week on work outside of class in preparation.

Approximately 15 apprentices to

the trade of tool making are hired each year. Only young men who have had a high school education in an industrial course, with high scholastic standing in such subjects as drawing, shop practice, science and mathematics are selected. Character, personality and evidences of ambition are all used as the basis of selection.

A new apprentice is placed on probation for six months in the machine shop, during which time his work is very closely supervised. If he demonstrates real mechanical ability during this probation period, he is definitely enrolled for the course. The first year and a half is spent in the apprentice machine shop where the boy learns the fundamentals of tool making. This training is supplemented by additional practical experience in the heat-treating department, the physical laboratory, and the machine repair department. At the completion of this preliminary period the apprentice goes on to a like period of 1½ years in the tool room. This completes his apprenticeship.

THEORY FOR APPRENTICES

During his course of training the apprentice takes two years of advanced shop mathematics, three years of technical machine shop practice, one year of metallurgy, one year of industrial organization, and two years of mechanical drawing. Upon graduation he is granted a diploma certifying that he has satisfactorily completed the prescribed course in tool making.

Another important phase of the I. B. M. educational program is the supervisors' school, which is attended by all factory supervisors and executives. Since there are approximately 100 men in this group, the school is divided into three sections of about equal numbers. The first section is made up of executives and supervisors; the second group includes the foremen from the machining department and allied departments; while the third group is made up of foremen of the various assembly departments and the departments closely allied with assembly.

ROTATING COMMITTEES

Each of these groups is directed by the men themselves through a committee of four who remain in office until each one of the four has served as chairman of the group for one meeting. Each committee consists of a chairman, a secretary and two discussion leaders. Once a week the committees representing the three groups meet for a two-hour conference to discuss the findings of the individual groups. As a result some very concrete and practical suggestions originate in the group meetings and are submitted to the management.

Three definite constructive results have been accomplished by the Supervisors' School. In the first place, the foremen and supervisors have become more familiar with company policy. In the second place, they have felt that they are a part of the management because their recommendations were given consideration. Finally, their interest in personnel problems has been aroused.

An important phase of the I. B. M. educational program is the training of young men for its sales and service field organization. Candidates for the sales schools are selected from the business world and the graduating classes of various colleges. Preference is naturally given to men having a knowledge of accounting, gained either through experience or through organized training of one sort or another.

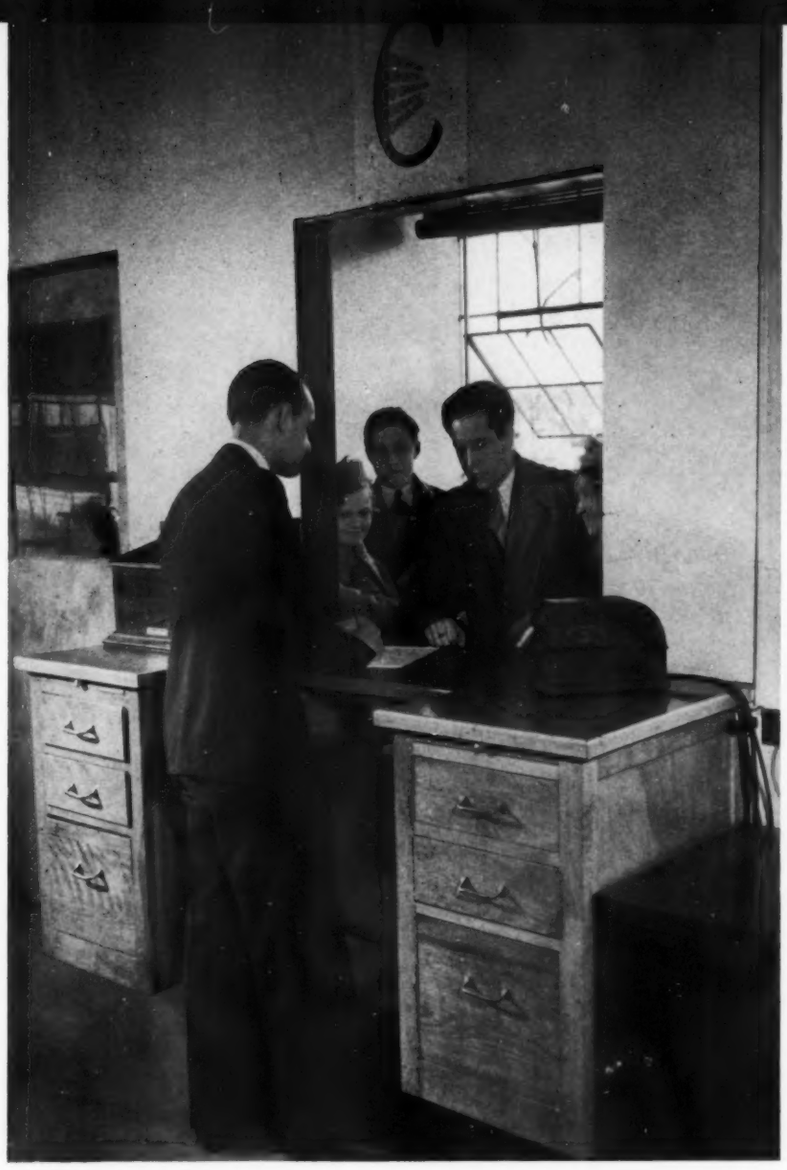
It is essential, of course, that a salesman have first a knowledge of the products of the company and a knowledge of their application to business problems. He must also have sufficient knowledge of a prospect's business so that he is able to recommend the best possible solution of his problems. Finally, he must acquire a sales technique that will enable him to convince the prospect of the advantages of the method he recommends. These things are taught in the sales school by men who have had years of experience in the field, meeting and solving just such problems. The regular course is supplemented by talks and discussions with experts who come in fresh from the field with new problems and new ideas.

TRAINING SERVICEMEN

The normal course of training for servicemen extends over a period of four months, about two-thirds of this time being spent on the actual assembling and disassembling of machines. They are taught how to correct the difficulties that they are likely to encounter in the field. During the course the customer service students are encouraged to spend some time in the shop outside of class hours and to make criticisms or suggestions for improvements that occur to them. This procedure is found to be decidedly stimulating to their powers of observation and to their ingenuity. After this four months' preliminary training period they are assigned to a district office, usually the one nearest to their home city, and after eight or ten months in the field, come back to Endicott for a post graduate course of several months. Upon the completion of this course they return to the field.

This educational system extends throughout the world. Schools are held in other countries, and representatives from other countries also attend schools in Endicott. While in the United States, they study methods and installations in this country, passing on their knowledge to their associates when they return. Extension courses, executive schools, and advanced schools are included in a program that recognizes the truth of Mr. Watson's declaration that "There is no saturation point in education."

Customers' Service Men in Training



A GOOD PLACE TO WORK

As evidenced by a sympathetic personnel policy, an outstanding safety record, and sports and recreations run by the employees through a country club to which 3300 belong

ENDICOTT and its sister cities, Binghamton and Johnson City, lie in an area that is not industrial. There is no pool of industrial labor on which to draw when extra help is needed. As a consequence, International Business Machines Corporation finds it necessary to hire unskilled labor from the immediate vicinity, studying each individual to determine where he will fit best and training him to make the most of his own possibilities.

Starting rates vary in different departments, the minimum rate being 65 cents an hour for qualified male and female workers. Every effort is made by foreman and by men higher up the administrative ladder to bring about individual progress and efficiency by teaching. All sorts of training courses are open to him without charge as is described in the article on the education and training system of the corporation. Besides programs there is the constant contact with his own foreman who has been trained in his turn to help every man under him just as much as he possibly can.

Wage rates are high at Endicott, and employment is remarkably steady. The effort is to give each man 52 weeks of work per year, with provisions for two weeks vacation with pay for employees having at least one year of service, and one week for those with 6 months' service. During the past year not over 5 per cent of the men have been laid off for more than three days. One of the expedients to tide over dull periods is to build up stocks of parts where shortages usually develop in active periods.

Wage incentives are not used in any of the I. B. M. manufacturing operations. The men are judged primarily on the quality of their output. Every conceivable mechanical help is provided to raise the output quantity.

INTERVIEWS AND TRANSFERS

The job of interviewing candidates for jobs and placing them in the right job is assigned to the Personnel Department. In addition this department is responsible for the transferring of men to departments where they may have a better chance of making good. It must also approve removal from the payroll after a man has been found wanting by his foreman and his department supervisor.

An effort is always made to get a final interview with a man to find out just what his reasons for leaving the corporation may be, if he leaves voluntarily. Before any man is fired he is warned, usually more than once, by his foreman, and each of these warnings is entered on his record so that if he comes up for discharge it will be clear that he had fair warning if he persisted in misconduct or other shortcomings. Any man who has a grievance can take it all the way up the line at Endicott, step by step, to the vice-president of manufacturing. It is a corporation rule that every man in a supervisory position must not fail to give a sympathetic hearing to any man farther down the line who comes to him with a complaint.

Each new employee during his first week is taken for a three-hour inspection trip of the plant by one of the regular guides so that he will get some sort of idea of the activities of the company for which he is working. He also gets a letter of welcome from the vice-president in charge of

Research Library in the Engineering Laboratory Building

manufacturing, explaining that he will have this trip and telling about the libraries, training courses and athletic and recreation facilities available to him. When he has been on the job 30 days he is interviewed to find out how he is getting along with his work and what use he is making of the various extra-curricular facilities at I. B. M.

In the plant hospital there are two nurses on the day shift and one on the night shift. The doctor spends one hour a day in the plant hospital. There is one male nurse who assists the doctor and visits the homes of absentees to see what is wrong and whether anything can be done to help out in emergencies. A physical examination is required on employment only, unless it becomes evident that something is wrong with one of the regular employees. In that case the doctor examines him, but does not prescribe for or treat his difficulty, whatever it may be. He is referred to his own physician for that purpose.

The plant suggestion system is under the supervision of the personnel department. Suggestion contests are run on a quarterly basis, a new one starting as soon as the current one has closed. Envelopes addressed to the department are obtainable from each foreman and the suggestion contained in the envelope is dropped in the regular plant mailbox. When it reaches the personnel office three copies are made of it, one of which goes to the suggester for his records. Unidentified copies go to the suggestion committee which is made up of representatives of the personnel, cost reduction, production, planning, assembly, inspection, engineering and machine room departments.

The suggestion committee values the acceptable suggestions and states its reason for rejecting the unacceptable ones. These reasons are given to the suggester. Prizes are given for the best suggestions and there is an annual dinner for the winners. Some 2,000 suggestions are made each year.

Some of the minor suggestions can be handled directly by the head of the personnel department. The majority are referred to the member of the committee best qualified to pass on them. The important ones are brought up before the full committee for final adjudgment.

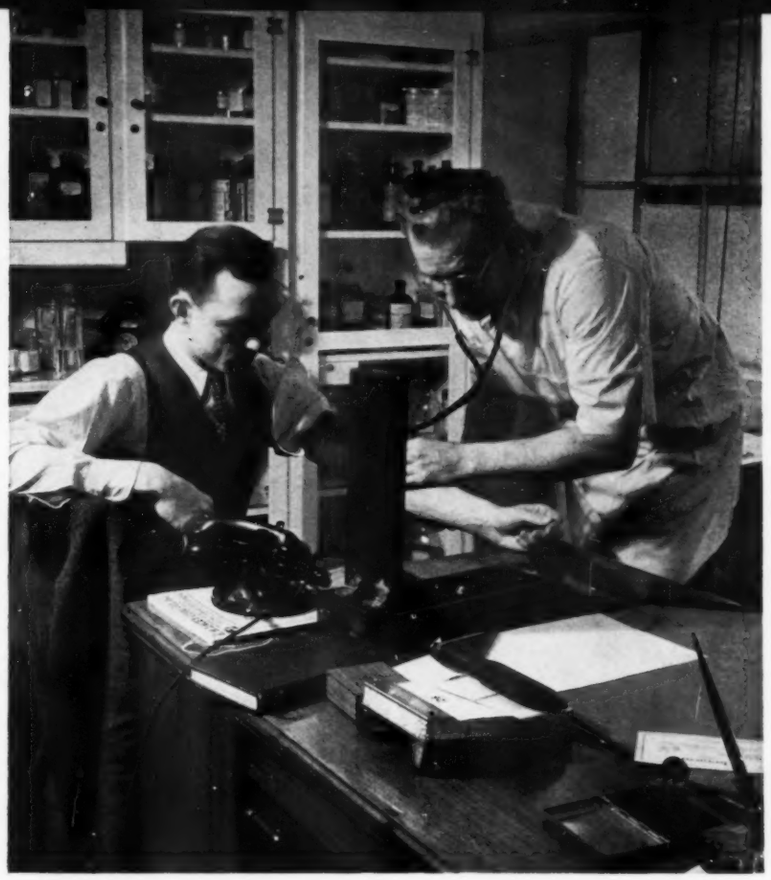
SAFETY

At the time the material for this article was gathered, which was during the week of April 5, the Endicott plant had operated without a lost time accident since the first of September. Stated another way, there had been 3,709,550 man-hours of work without a lost time accident. Looked at either way this is a safety record worth while. Such records do not just happen. How are they obtained?

At Endicott the safety committee which is composed of one or two men from each department—there are 40 in all—meets once a month. To be strictly accurate this committee of 40 is divided into two committees of 20 each so that there is a safety meeting every two weeks. In addition all of the foremen and the six supervisors meet once every three months with the safety supervisor.

Monthly meetings of the safety committee last 30 or 40 minutes and are scheduled for the last half hour of the working day, on Thursday of alternate weeks. The program consists of a short talk by the safety supervisor on some recent large scale accident which has a moral or a lesson for the I. B. M. safety men. This talk may last 10 or 12 minutes. It is followed by an open discussion of any bad condition in any department that might be remedied from the safety viewpoint. The danger spots are reported by the man in the department, and his report is noted by the supervisor who investigates immediately.

Each safety man gets a list of possible trouble that might lead to lost time accidents or accidents of any sort, checks it for his department and hands it back to the safety supervisor



through his foreman. It is the duty of the supervisor to inspect the danger points checked by the safety man of the department.

THREE TIME WINNER

In the nurse's office adjoining the personnel department are three bronze plaques won by I. B. M. for the best safety record in its division for the years 1933, 1934 and 1936. The first position was missed by a few points in 1935 and an honorable mention was awarded. Each department throughout the factory is marked by a large sign which gives its name, the name of the foreman, and the safety record of the department. Safety devices are used at every possible point and one such device which was invented by an I. B. M. employee has been made available to other companies that have heard about it.

The future of the families of the employees, in case of death, is protected, through group insurance the entire cost of which is borne by the corporation. Every employee with the corporation one year receives an insurance policy of $1,000.00; employees with two years service receive an insurance policy of $2,000.00; and employees with the corporation three or more years receive a policy to the amount of $5,000.00 each.

There are appreciable numbers of men with 25 years or more of service. When a man has been 25 years with the corporation he gets a gold watch, a certificate of honor for membership in the Quarter Century Club, an additional $2500.00 insurance policy, and a trip to the annual One Hundred Percent Club convention at New York. So few of the employees have reached the 40-year standard that no regular procedure for them has been worked out. Each man that does attain that honor gets a certificate, however, and other valuable considerations depending on the circumstances governing his particular case.

There is among the factory employees a Relief Association which started in the International Time Recorder Division in the early days before the corporation was formed. This organization was organized in 1898. Membership dues are 50 cents per month and the usual sickness and death benefits are paid.

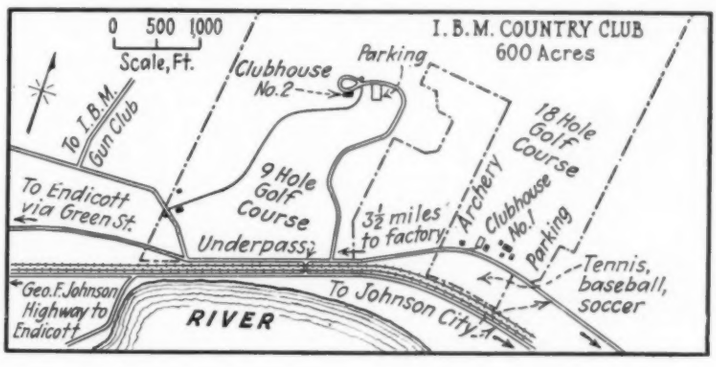
One of the functions of the personnel department is to send to every employee who requests it copies of the weekly magazine of the Corporation, "Business Machines" and the monthly magazine, "Think".

SPORTS AND MUSIC

Since Endicott is not a very large community, considerable attention has been paid to developing recreational and athletic facilities for the employees. These activities are initiated and directed by an employee organization with its own elected officers. Included in these activities are a country club with two club houses and two golf courses, a baseball diamond, soft ball diamond, archery range, quoits and horseshoes pitch, a gun club for trap, skeet, rifle and pistol shooting, bowling alleys, pool and billiard tables, tennis courts, ping-pong tables, shuffle board, basket ball court, etc. Each of the 3300 members pay dues of $1 a year for himself and an additional dollar for relatives including wives, sons and daughters over eighteen, mothers and fathers. Greens fees on the golf courses are 25 cents a day or $7 a year; bowling costs 10 cents a game, and equipment is available at low cost. There are two golf pros whose services to the members are given free.

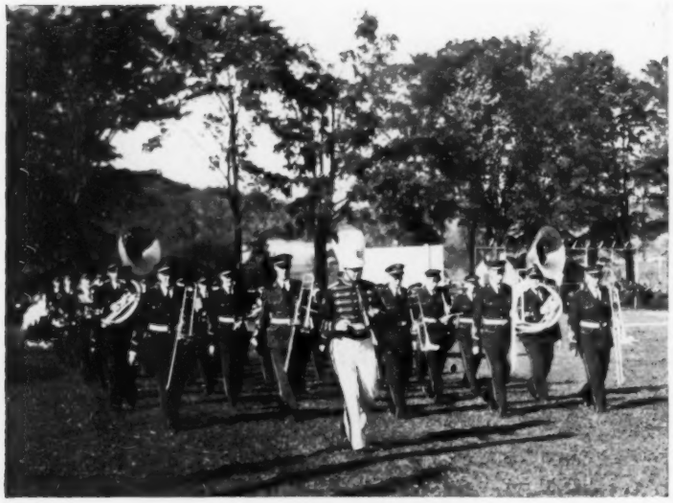
There are some 500 in the Bowling League playing 3,000 games a week on the average. There are four teams in the Baseball League and 22 soft ball teams.

In addition to the athletic activities there is a male chorus of 60, a girls' chorus of 40, a girls' drill team of 48, a company band, an orchestra and a glee club, all of which have facilities for practice in the engineering laboratory building. The company maintains the property for the various sports activities and also a picnic ground which lies on the hill back of the club houses. Illustrations that follow show some of the many outside activities in which I. B. M. employees engage. With 700 acres of rolling country available there is room for everybody.



I. B. M. RECREATIONS

A V.-P. ROLLS ONE



HERE COMES THE BAND!

STRIKE!

RINGERS COUNT

ON THE FIRING LINE

THE GIRLS ARE GOLFERS TOO

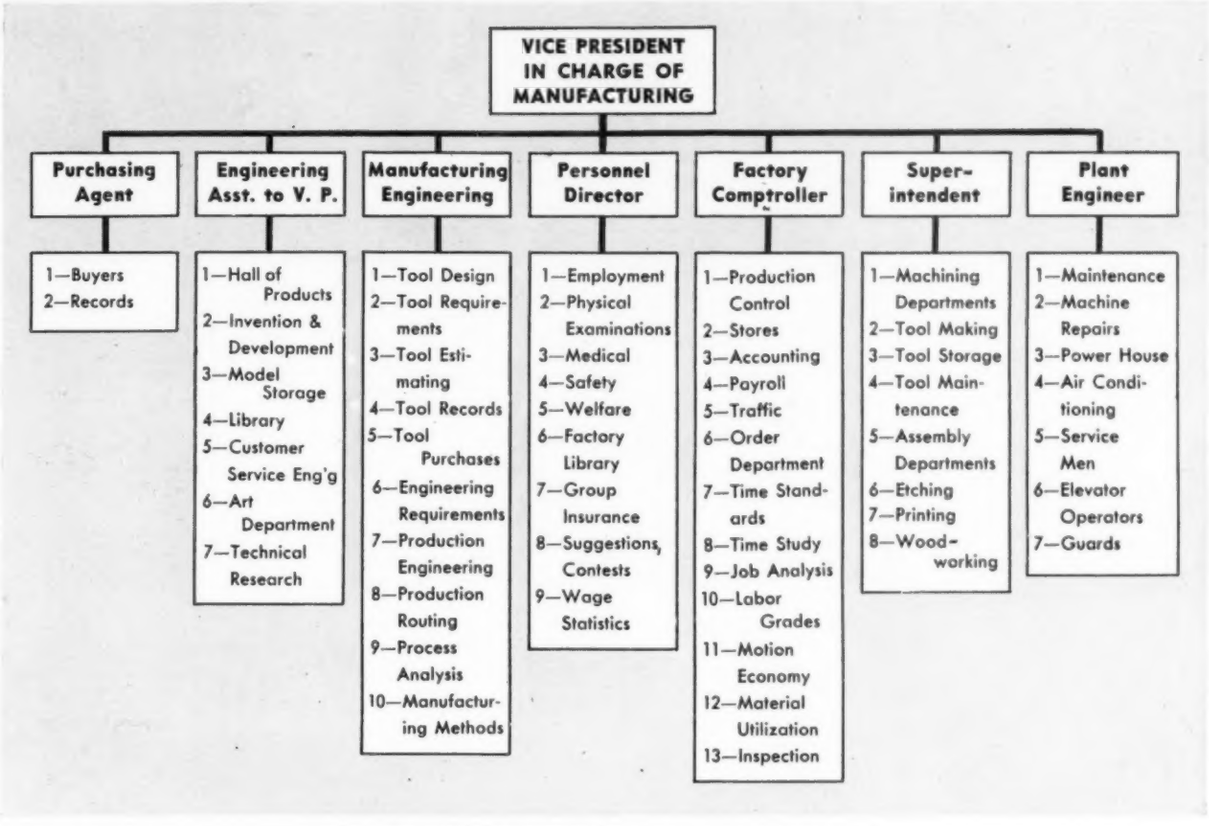
EXERCISE DELUXE

HOME GROWN MINSTRELS

(Above)

MR. WATSON SPEAKS — AND RELAXES

I.B.M.'S MODERN *Factory buildings are as attractive as they are efficient*



DIVISION OF RESPONSIBILITY *between supervisors on the staff of the vice-president in charge of manufacturing*

PRODUCT AND PROCESS CONTROL

Management and methods are tailored to suit the 253,000 operations performed on a job-lot basis

SUPERVISION and control of processes and individual operations requires a staff of capable, well-trained men who can coordinate their activities to the best advantage. Organization of the plant is on the line-and-staff basis, with all division heads reporting to W. F. Titus, vice-president in charge of manufacturing. Responsibilities assigned to each member of the vice-president's staff are outlined in the accompanying summarized organization chart.

Related activities are grouped for efficient supervision. Coordination of activities of the various departments is such that full advantage is taken of all possible improvements in product design, in working conditions, in manufacturing processes and in tools and equipment.

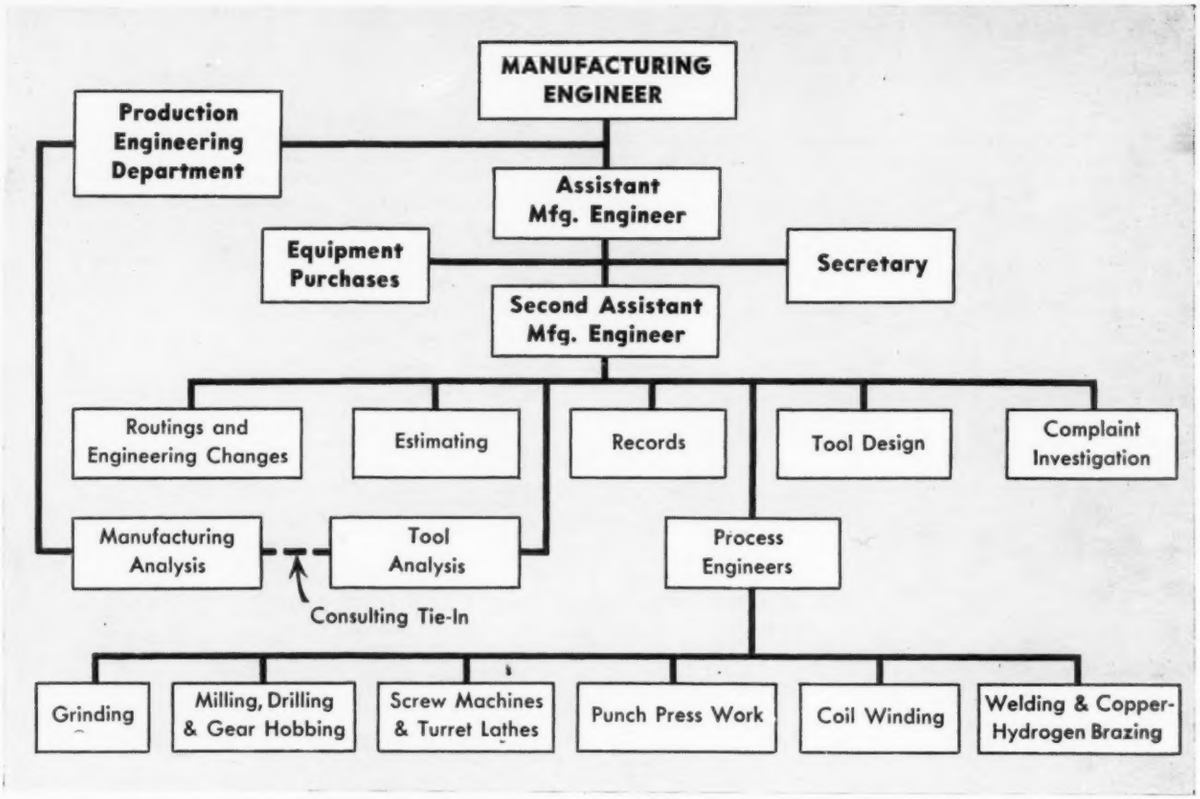
In spite of increasing production quantity requirements, quality of product and manufacturing methods have been continually improved and production costs have been reduced. This has been accomplished, despite increases in labor and burden costs, without driving or coercing the working force.

MANUFACTURING ENGINEERING

Activities assigned to the manufacturing engineer include supervision of processes and methods, tooling programs and tool design, equipment purchases, production routing and engineering investigations in connection with the product. These are divided into two major groups. Product and manufacturing analyses are the responsibility of the production engineering department; supervision of the other activities is outlined in the accompanying chart.

Analyses of the company's products have shown that, on the average, part designs have a life expectancy of about 3½ years. New tools and fixtures are authorized if they can be made to pay for themselves in not more than that length of time. Specially designed machine tools that become obsolete if the part for which they are purchased is redesigned are subject to the same amortization requirements. Standard machine tools are purchased on a sliding scale of amortization limits, each case being considered on its own merits.

Machine obsolescence is considered a more important factor than ordinary depreciation in determining



ACTIVITIES *of the manufacturing engineering department are supervised by specialists*

whether or not a given unit should be replaced. Machine and tools are worked to the limit, which is considerably beyond common practice in the average machine shop. Machining speeds and feeds are, for the most part, in the upper range of the capacity of the machine—even though close tolerances and good finishes are required. Cuts are usually light, which permits unusually high cutting speeds.

A ⅜-in. square slot, 14 in. long, has been successfully milled in mild steel with a high-speed steel cutter operating at a peripheral speed of 1,100 ft. per min. Feed was 40 in. per min. This was done with coolant flooded over both the test piece and the cutter. There was no indication of any damage to the cutter.

MACHINE TOOL COMMITTEE

Purchases of manufacturing equipment are authorized by the machine tool committee after certain fundamental conditions are met. It must be satisfactorily shown, in the first place, that the purchase is justified by shop requirements. Then, since quality of the product must be held to exacting standards of accuracy and finish, only first grade equipment is purchased. Thirdly, every machine known to the company that satisfies the quality requirements is given consideration.

This committee is composed of the factory superintendent, the manufacturing engineer and his assistant, the equipment purchase engineer and the supervisor of the machine shop. The equipment purchase engineer, who reports to the manufacturing engineer, prepares equipment surveys and purchase recommendations for submission to the committee.

Back of the constant effort on the part of all shop employees, whether supervisors or workmen, to obtain maximum operating efficiency and better working conditions is the group of process engineers. These manufacturing specialists, working under the direction of the manufacturing engineer, have been selected for proven ability and technical knowledge.

Fields of activity covered by these men include milling, drilling and broaching operations, grinding, coil winding and so on.

In the shop, the process engineer furnishes consulting assistance to the foreman to make the operator's work as convenient as possible and to remove conditions that cause fatigue. Every conceivable safeguard is provided to protect the body and health of the workman. The second aim is for improvement, both of product and manufacturing methods, so that maximum production consistent with economical tool life may be obtained. All parts are continually examined for possible improvement in design or method of manufacture. Operations and tools are frequently improved or, in some cases, eliminated.

FACTORY COMPTROLLER

Production and quality control functions have been placed under the supervision of the factory comptroller. This is in addition to the accounting functions ordinarily supervised. This arrangement has been particularly satisfactory.

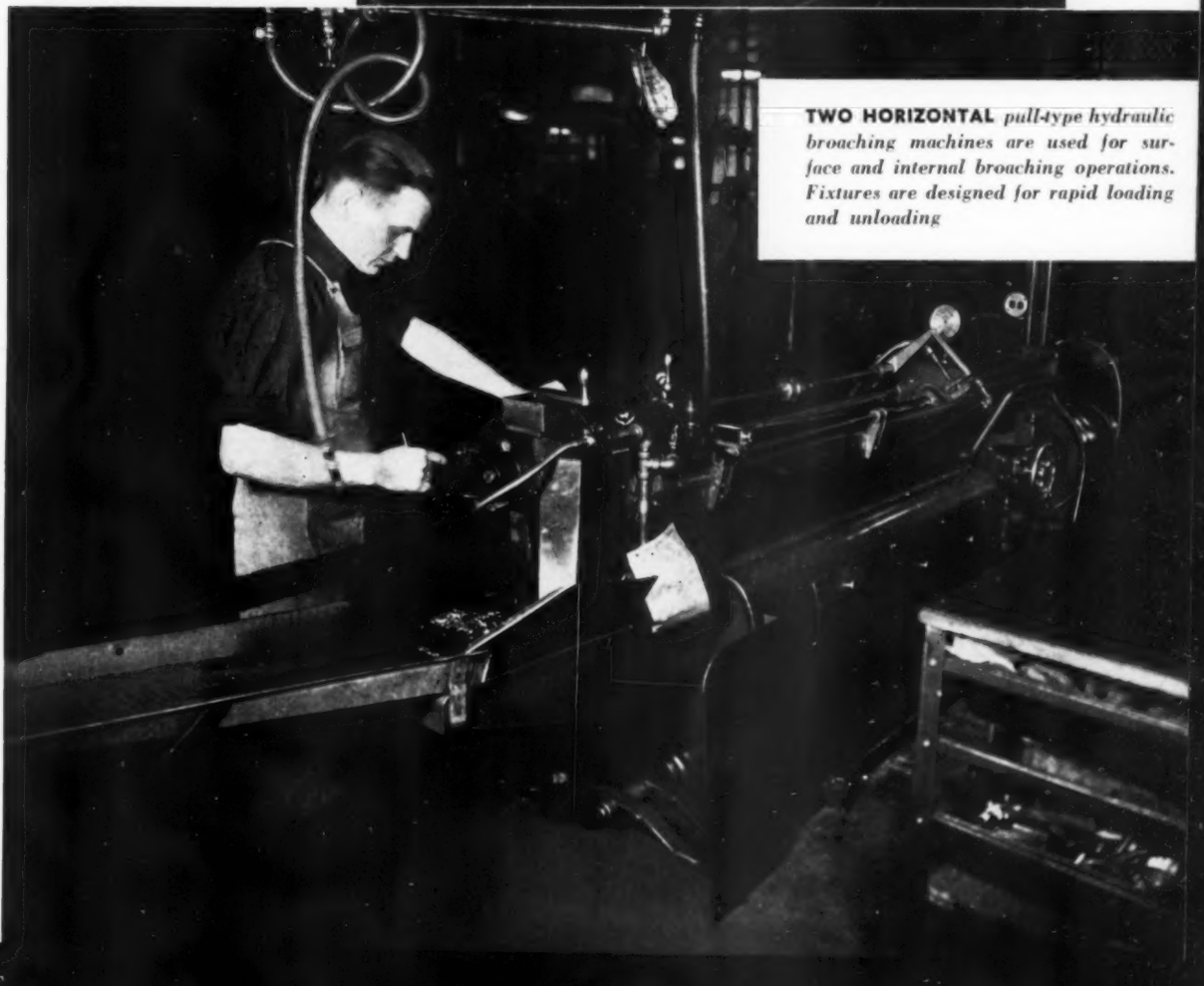
Successfully taking its own medicine, I.B.M. uses standard accounting and tabulating machines wherever possible. The production planning and control system, which includes an accurate perpetual inventory control, has been designed to use machine written records and requisitions for

SURFACE BROACHING

TWO vertical and two horizontal Oilgear hydraulic broaching machines are kept busy on surface finishing operations with considerable reduction in manufacturing costs as compared with previous methods. Broaching tolerances as low as + 0, — 0.0005 in. are easily held. Cutting speeds of 12 to 20 ft. per min. have been found suitable for most operations.

Wherever possible the broaches and fixtures are arranged to finish all surfaces at one pass. Two pieces are frequently cut at the same time. Broaching fixtures used on the vertical machines are now arranged for rack and gear connection with a pneumatic cylinder mounted on the column. Clamping is thus only a matter of operating an air-valve.

CONTROL LEVERS *on the vertical machines are mechanically interlocked for the protection of the operator. Two levers, one at each side of the operator, must be pulled before the slide can start a cut stroke. Pneumatically clamped fixtures reduce between-cuts time*



TWO HORIZONTAL *pull-type hydraulic broaching machines are used for surface and internal broaching operations. Fixtures are designed for rapid loading and unloading*

MACHINE TOOL *purchase recommendations are referred to the machine tool committee for approval*

practically all purposes. Raw material and tool requisitions are the only handwritten orders issued under this system.

Production planning at Endicott is done on a quarterly basis; average monthly requirements for 40 classes of machine units being determined from sales forecasts, interpreted on the basis of past experience. Shipments are anticipated five months in advance, one month being required for paper work, three months for manufacturing the parts and one month for assembly operations.

Once the production budget has been prepared, master order cards are originated for all planned assemblies and sent to the master production control file. Here are groups of punched cards, each group containing a card of identifying information for each component part in a major or sub-assembly.

Card groups are pulled from the file for each master order and bills of material prepared on the alphabetic tabulator. Stock requisitions are reproduced from the master cards, and these are filed with the bill of material until assembly orders are released. They are then sent to the finished parts stock room to release material to the assembly departments.

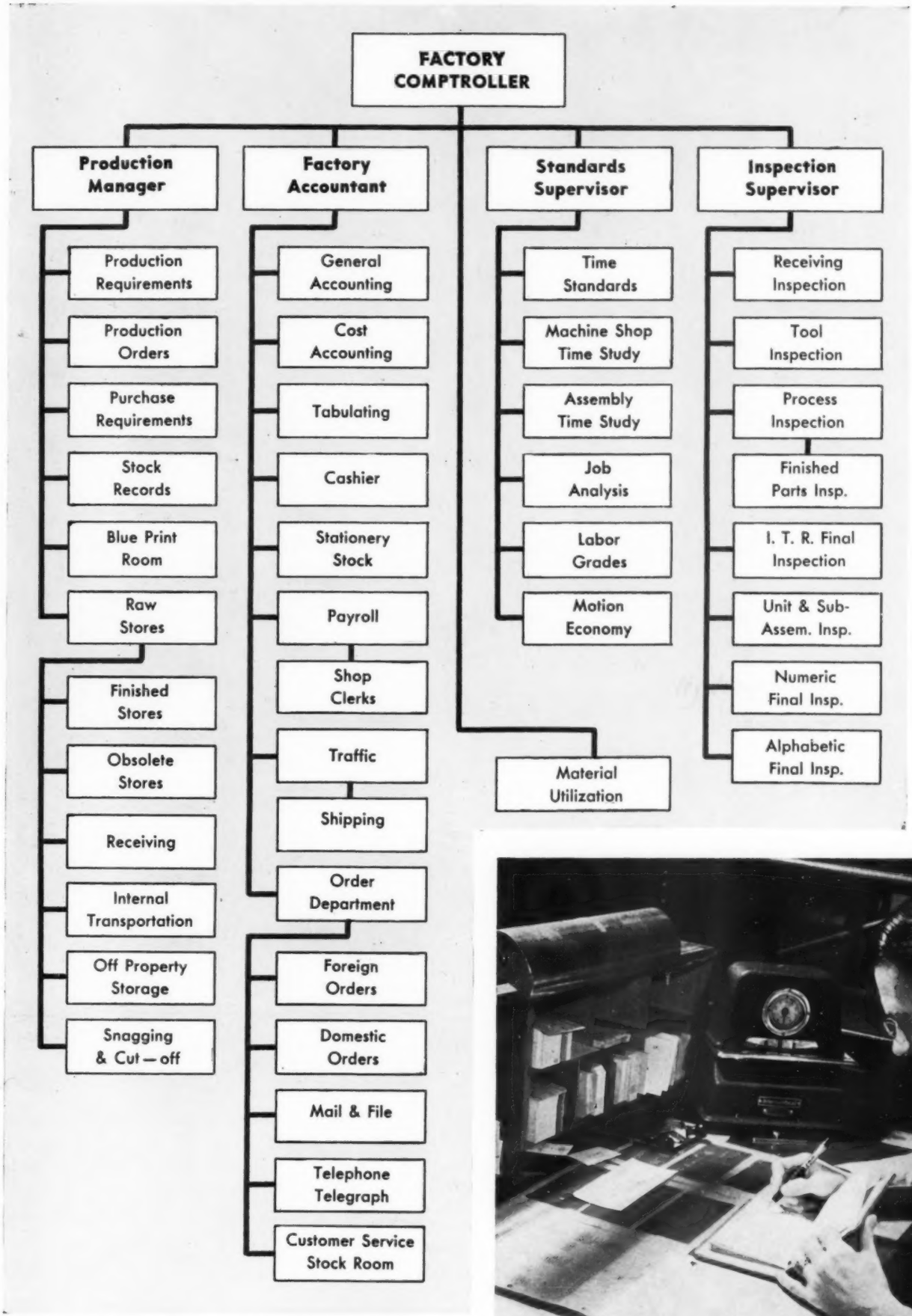
Stock reservation cards are also reproduced from master file cards, requirements are extended automatically, and all assemblies are broken down into component parts. Component part requirements are tabulated mechanically and, where the perpetual inventory shows insufficient stock, orders to manufacture are originated.

Data compiled in the production department give economical lot sizes, routing, and time required to produce each part and sub-assembly. Every order sent to the machine and assembly departments is scheduled by operations, so that the foreman and set-up man will know when to start the job and when it must be completed.

Machine-hour load records are tabulated and operations are scheduled accordingly. Delivery of the operation record and scheduled labor cards to the machine shop authorizes manufacture of the parts.

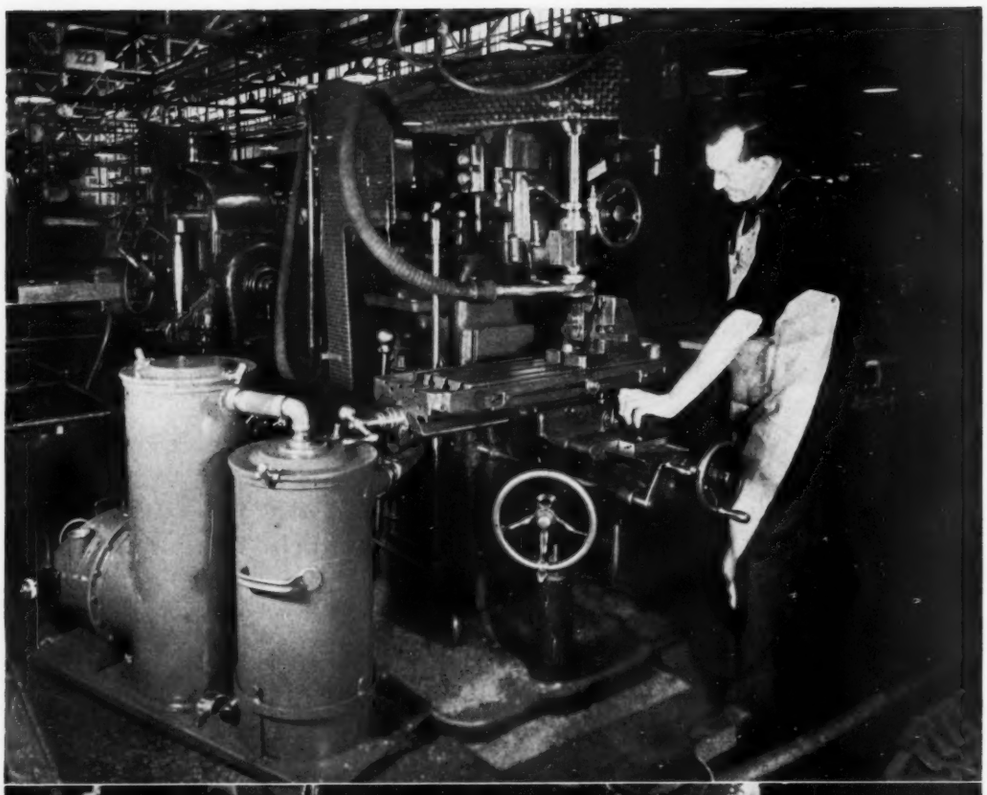
Upon completion of the order finished parts are delivered to the stock room and order cards are returned to perpetual inventory. Labor cards, turned in upon completion of each operation, go to the accounting department for cost and payroll purposes.

It is to be noted in the above that all planning presupposes a supply of finished parts available in stock. It is only when reservation cards checked against perpetual inventory cards show an "under available" balance that manufacturing orders are issued. Periodical physical counts insure accuracy of records.

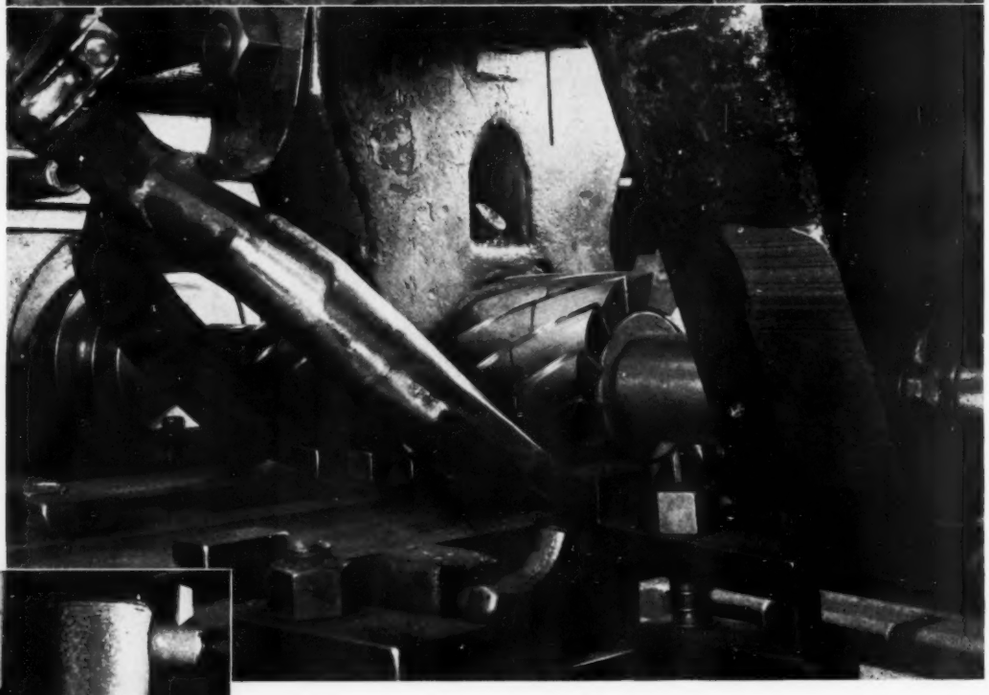


PRODUCTION CONTROL, *factory and cost accounting, time standards and inspection functions are coordinated under the factory comptroller*

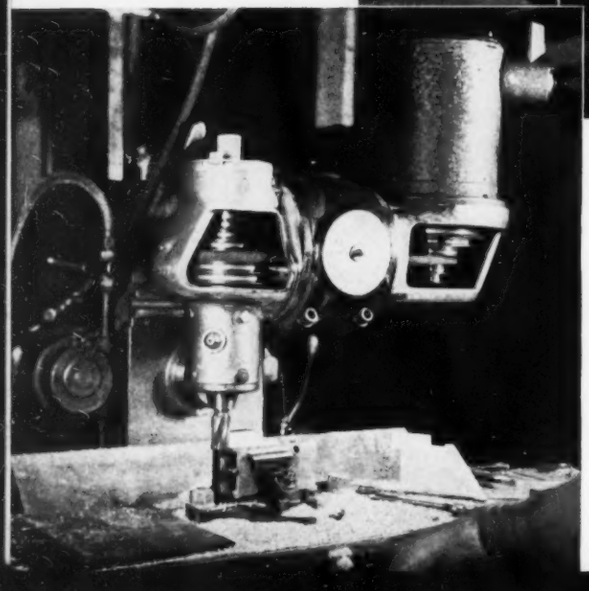
I.B.M. TABULATING *and accounting machines perform the major portion of the clerical work involved in production planning and control*



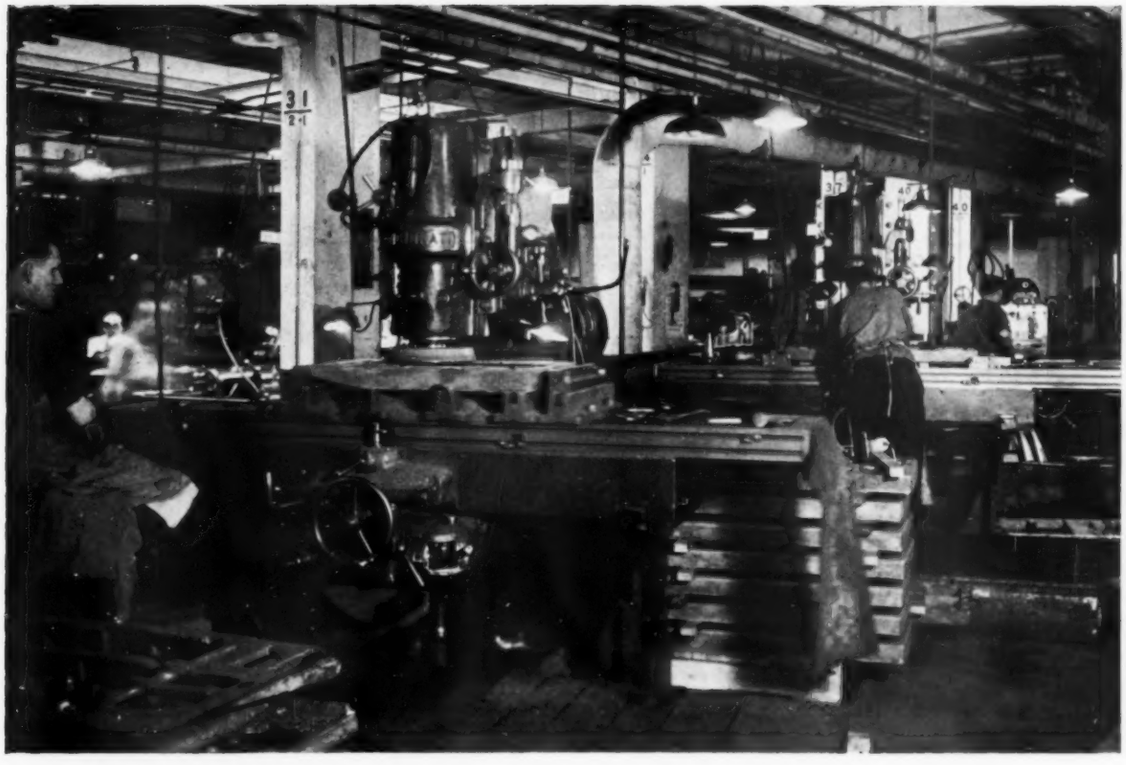
VACUUM REMOVAL *of brass, cast-iron and non-metallic chips has proven advantageous. Special suction nozzles are set close to the cutter. Operator is shown milling hard-rubber moldings with a 4-in. diameter stepped cutter operating at 900 r.p.m. Feed is 22½ in. per min. and time is 1.2 hr. per 100 pieces*



CUTTERS OPERATE *at lower temperature when vacuum is used to remove chips. Machine and fixture are kept relatively free of chips and dust*



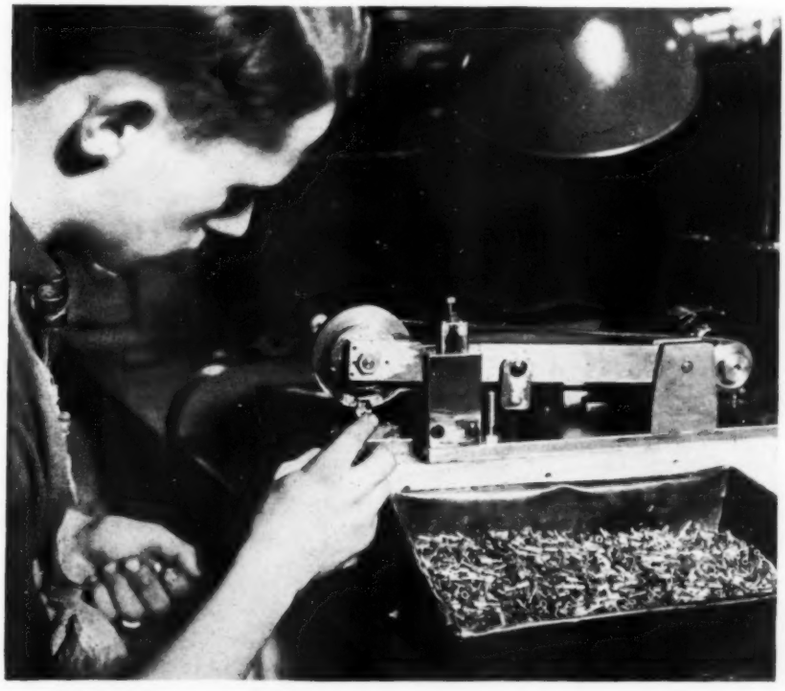
DALRAE HIGH-SPEED MILLING HEADS *have been mounted on standard knee-type millers for use on operations requiring small end-mill cuts. Spindle speeds ranging from 350 to 3,500 r.p.m. are available*



ALL MACHINING OPERATIONS *on the large cast-iron bases used for I. B. M. accounting machines are done by a group of two No. 4 vertical and one No. 4 knee-type millers and one 5-ft. radial drill. These large, thin-sectioned castings are shifted from machine to machine by tramrail hoist*

MILLING

Each part requiring a milling cut is analyzed for maximum use of available tools and equipment



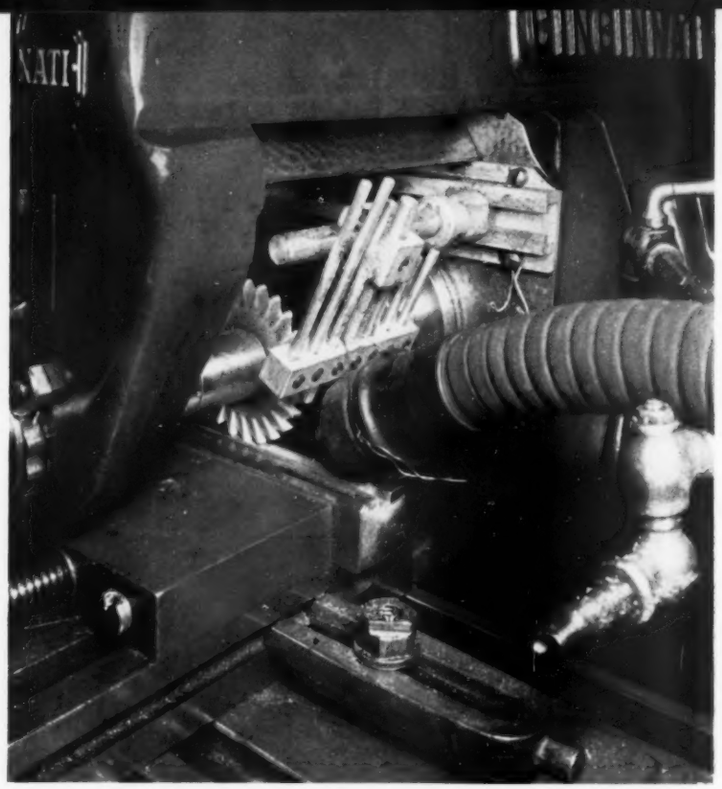
SPECIAL BENCH MACHINE *with treadle control of swing-arm is used for milling a flat on the side of tapered brass contact plugs. These ¾-in. long plugs are positioned by hand in a clamp and milled one at a time—production is 4,500 pieces in an 8-hr. day*

MILLING CUTS on steel parts with high-speed steel cutters operating at 220 to 250 surface ft. per min. are common. Feeds of 10 to 30 in. per min. are used in connection with these cutter speeds. High speeds and feeds, up to the maximum available, are used for non-ferrous metals and molded products. In some cases rapid traverse feeds of 100 to 400 in. per min. are used.

Nothing is taken for granted in determining the type of cutter and the speed-feed combination to be used. Trial cuts are run on all jobs before standards are set. Rapid removal of chips from the point of cutting and the proper application of coolant have been found necessary for successful use of the higher combinations.

Brass, cast-iron and bakelite chips are being successfully removed by vacuum, using an industrial type Spencer turbine vacuum cleaner. Suction nozzles of sheet metal are designed for the operation and are

A 4-IN. DIAMETER CUTTER *operating at 1030 r.p.m. mills a slot ¼ x 1/32 in. deep in bakelite strips 6⅛-in. long. Rapid traverse of 400 in. per min. is used as feed. This is maximum speed and feed obtainable on the No. 1-12 Cincinnati miller. Chips are collected by vacuum*



connected by flexible hose to the turbine unit. Steel chips cannot be handled because of the coolant.

Several advantages are claimed for this method of removing chips. Machine and fixture are kept relatively free of chips and the operator does not have to spend so much time cleaning away chips between pieces. and at the end of the job. Dust is reduced to a minimum, which is consistent with the company's established policy of keeping working conditions at a high level. Also, it is claimed that the vacuum removal of chips keeps the cutter working at a lower temperature than when a stream of air blows chips away.

Climb-milling cuts are being taken where the piece can be properly supported and the machine has sufficient capacity. Close tolerances for size and finish are common; tolerances of ± 0.0005 are not unusual.

Where gang cutter set-ups can be used the cutters are kept on the arbor in the tool crib and issued as a unit. Grinding is done without disturbing the arbor unit.

DROP-FORGED CONTACT BALE LATCHES *of S.A.E. 1020 steel are form milled to close limits. A 3½-in. high-speed steel form cutter operating at 191 surface ft. per min. with an 8½-in. per min. feed permits a standard production of 534 pieces in 8 hr. Operator checks the milled surfaces with a special gage*

CUTTER COLOR CODE

Where milling cutters made from or tipped with different materials are carried in the crib, identification of cutter material without reference to some data sheet is ordinarily difficult. The cutter used is a limiting factor and use of the right cutter is essential.

Color coding of milling cutters, as worked out at Endicott, permits easy identification of cutter material. Supervisors are able to determine immediately if a job is correctly tooled and operators lose little time looking for the right cutters.

Each cutter is painted on a non-working surface with one of the following colors:

CUTTER MATERIAL	COLOR
High-speed steel, new	Green
High-speed steel, recut	Yellow
Cobalt high-speed steel	White
Tungsten high-speed steel	Orange
Carlboloy	Red
Stellite J	Blue

SHOP SUPERVISION

Departmentalization of the shop is on a functional basis. Diversity of product makes production lines inadvisable

THROUGHOUT the shop similar operations are grouped together and, except in isolated cases, manufacturing equipment of similar types and sizes are placed side by side. Supervision of shop operations is divided in the same manner.

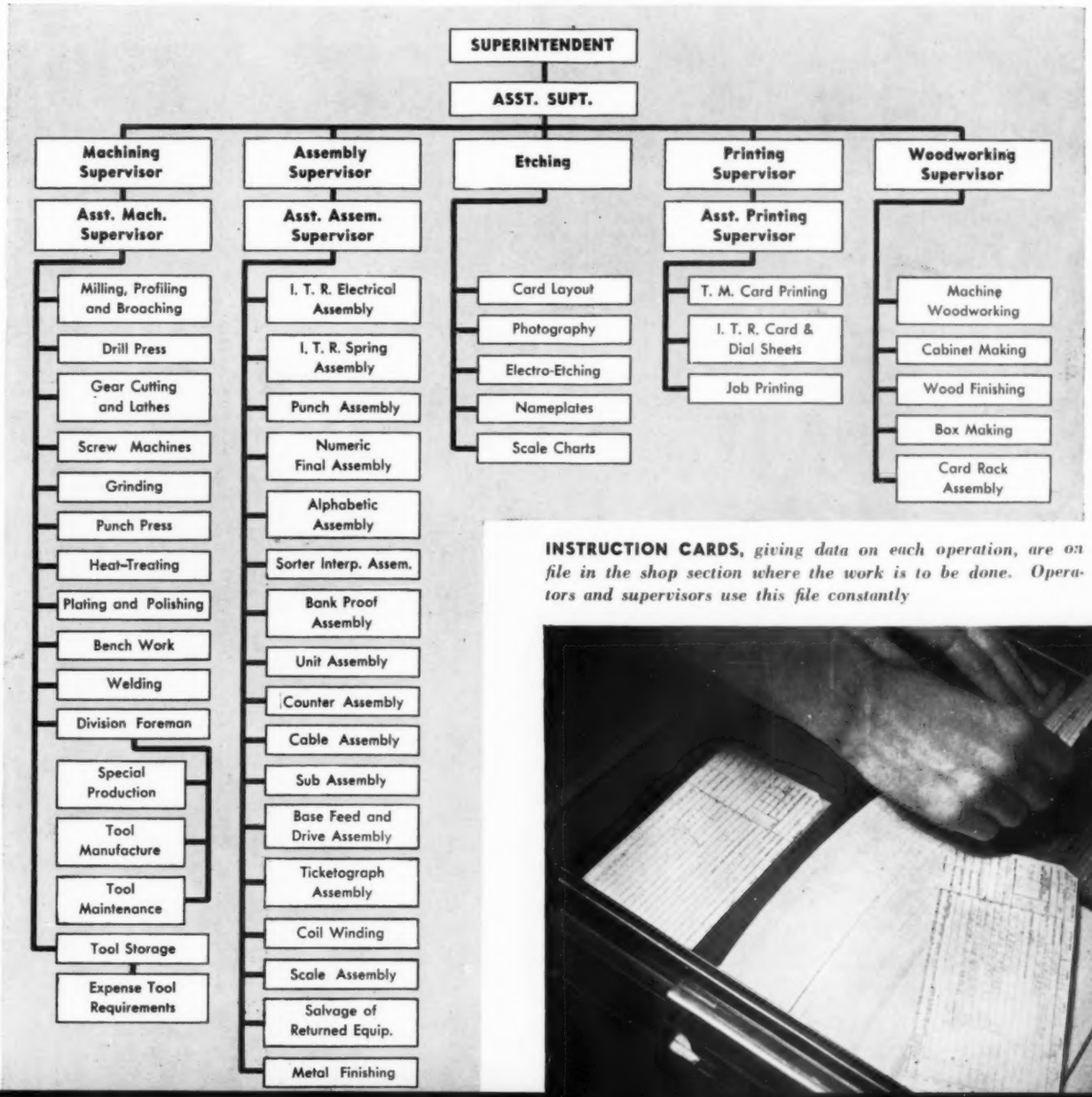
Analysis of the accompanying shop organization chart indicates the extent of this division. All shop sections are supervised by foremen, whose desks are located in the shop where they can give continual attention to the work in progress.

Set-up men, experienced on the machines to which they are assigned, assist the operators of production equipment in starting new jobs and in keeping the work moving.

Before an operator completes the job in his machine, he fills out a job ticket to advise the set-up man that he will need a new job. The set-up man then selects a new job for the operator, requests delivery of material and tools and checks the job when it is ready to run.

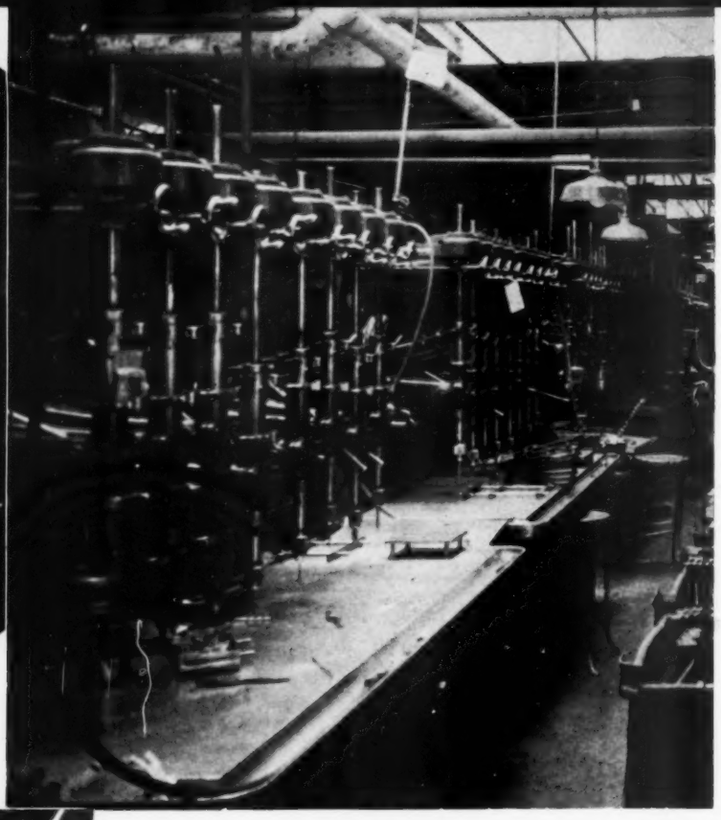
There are about 225,000 machine shop operations, averaging five operations for each of the 45,000 parts. Each of these operations must be started in time so that deliveries can be made according to schedule. Each must be properly performed and each must meet rigid inspection requirements. The set-up man carries a large portion of this responsibility.

Jigs and fixtures are used wherever possible, in order to maintain part quality and reduce manufacturing costs. Every drilling and tapping operation is performed with the aid of jigs or templates. Where parts cannot be held in vise jaws for milling, fixtures are provided to permit economical production to close tolerances.

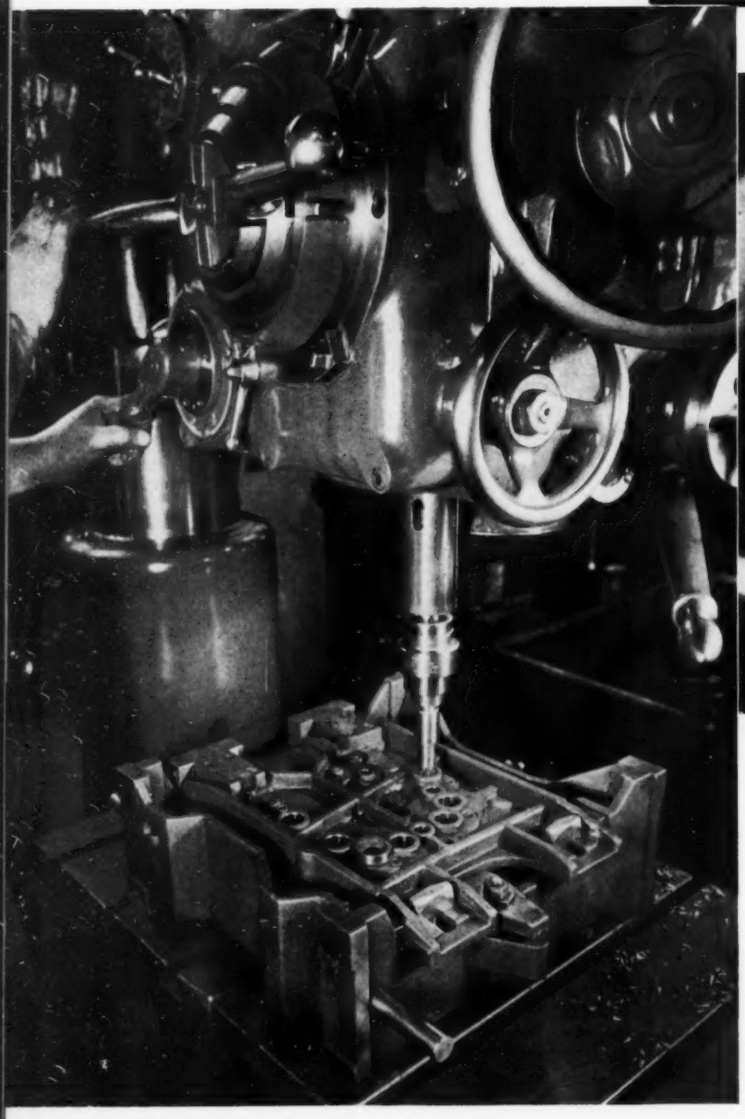


INSTRUCTION CARDS, *giving data on each operation, are on file in the shop section where the work is to be done. Operators and supervisors use this file constantly*

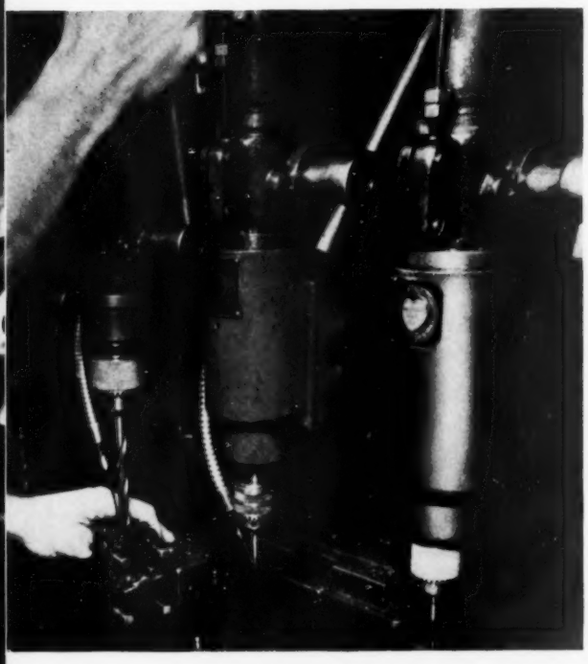
QUICK-ACTING CHUCKS *reduce floor-to-floor time when holes of different diameters are to be drilled or reamed*



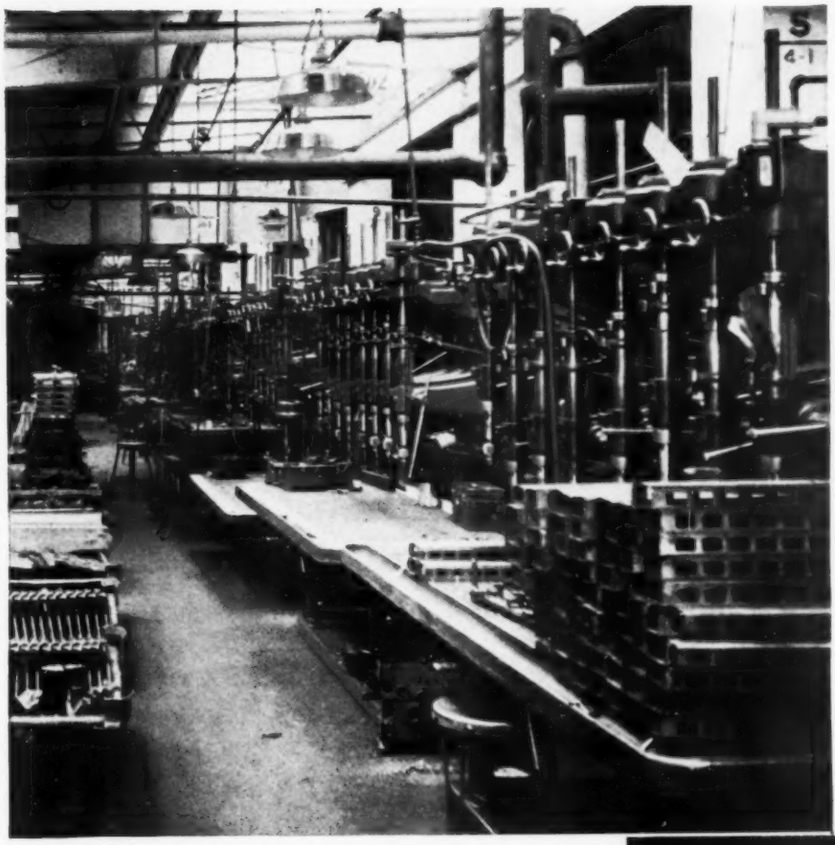
MACHINES OF SIMILAR SIZE *and capacity are grouped*



JIGS AND TEMPLETS *are provided for all drilling, reaming and tapping operations*



TAPS, COUNTERSINK AND BURRING DRILL *operate at 4,800 r.p.m. Two tapping heads and two drill spindles are used for a Norway iron part. Nine holes are tapped, one hole is countersunk and two holes are burred. Production is 900 pieces per 8 hr. day*



together for economical routing of work and ease of supervision

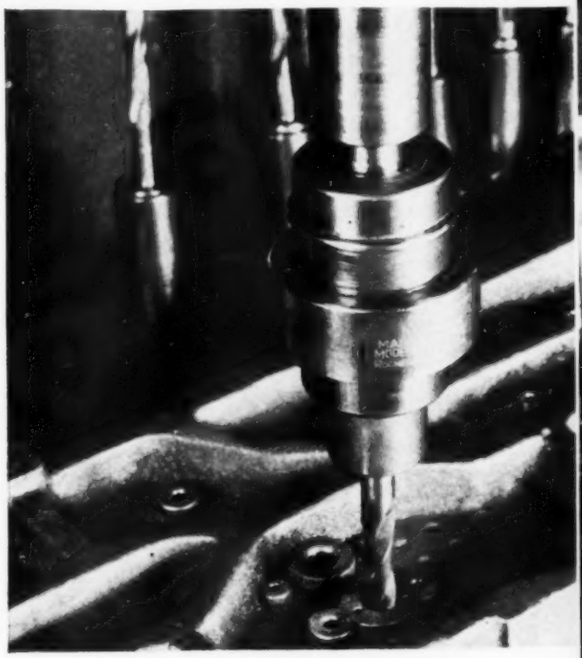
DRILLING

DRILLING and tapping operations are concentrated in a separate division of the machine shop. Here 128 men drill an average of ten holes in each piece that passes through the division; about half of these holes are tapped.

All drilling, reaming and tapping is done in jigs or according to templates; no holes are drilled to layout. Holes are drilled in fifteen kinds of material to minimum tolerances of ± 0.0002 in. on diameter and + 0.0005 — 0 on hole location. Size ranges from a 0.010-in. drilled hole up to a 3½-in. counterbore.

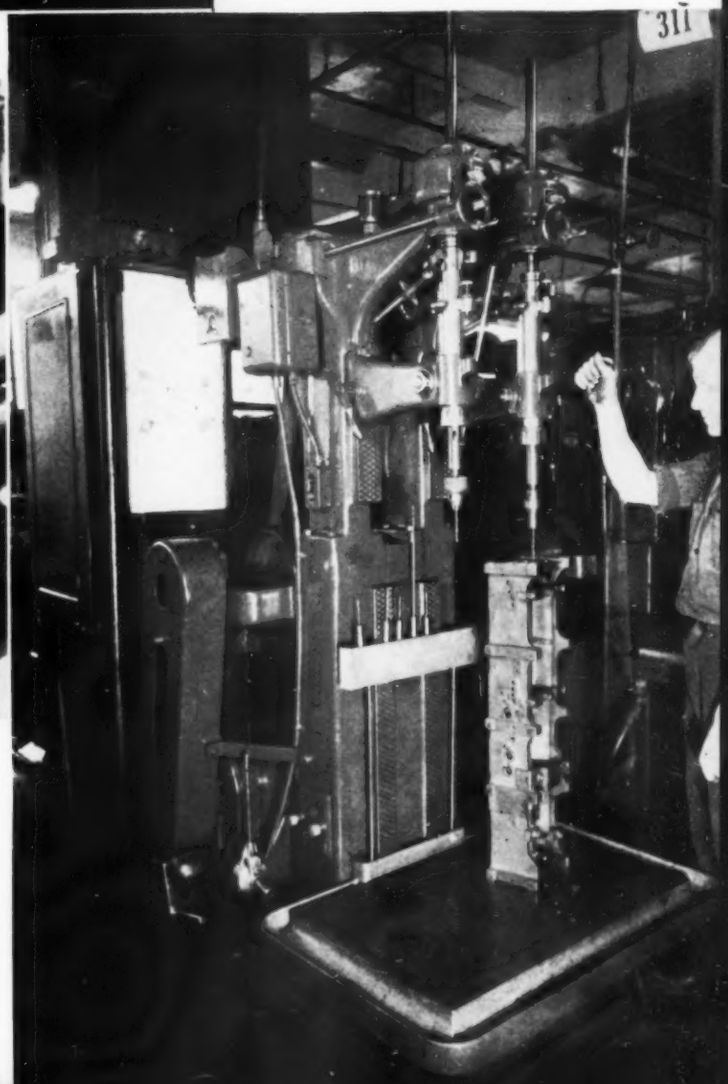
No advantage has been found in chromium plating drills or taps to be used in steel or cast iron. A 0.0005 in. thick chromium plate on drills and taps used in bakelite and similar materials is, however, claimed to give about 30 per cent more life between grinds.

Stepped drills and reamers are



CAST-IRON DUPLICATE KEY PUNCH BASES *formerly required 42 spindles for drilling, reaming and counterboring the more than 120 holes. Use of "Magic" drill chucks has reduced the number of spindles to ten. One operator now completes 16 pieces per 8 hr. day. Previous production was 9 pieces per day*

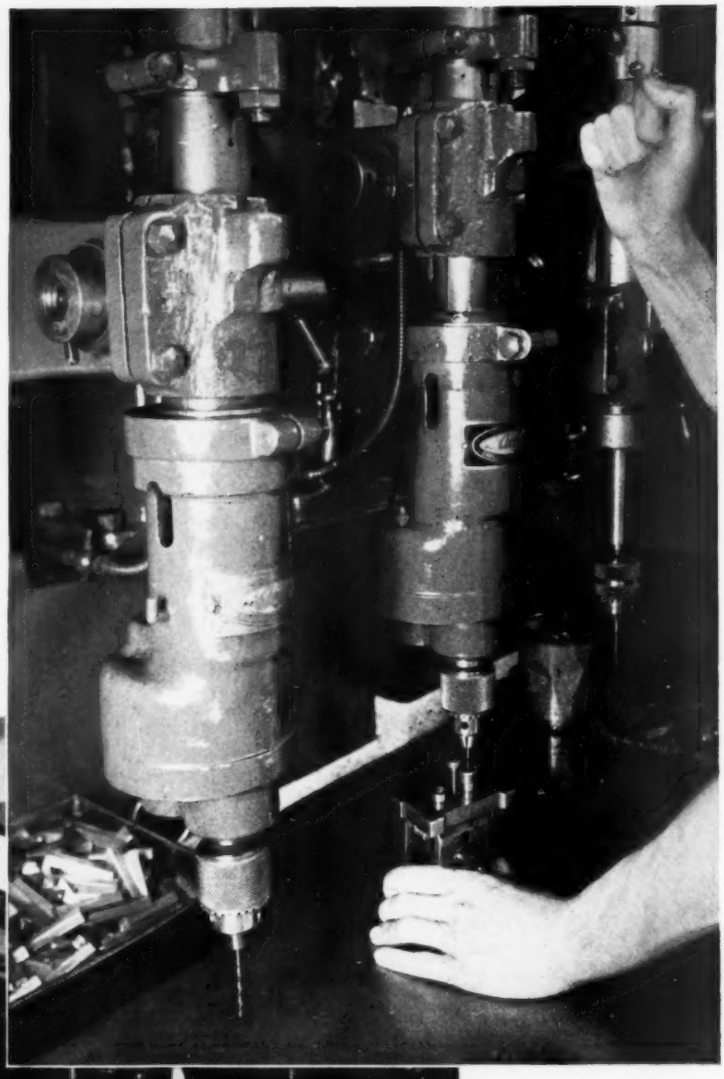
HOLES IN THE ENDS *of the duplicate key punch bases are drilled in a 2-spindle No. 2 Avey sensitive drill. Drills fitted in "Magic" chuck collets are placed in a rack, mounted on the machine column*



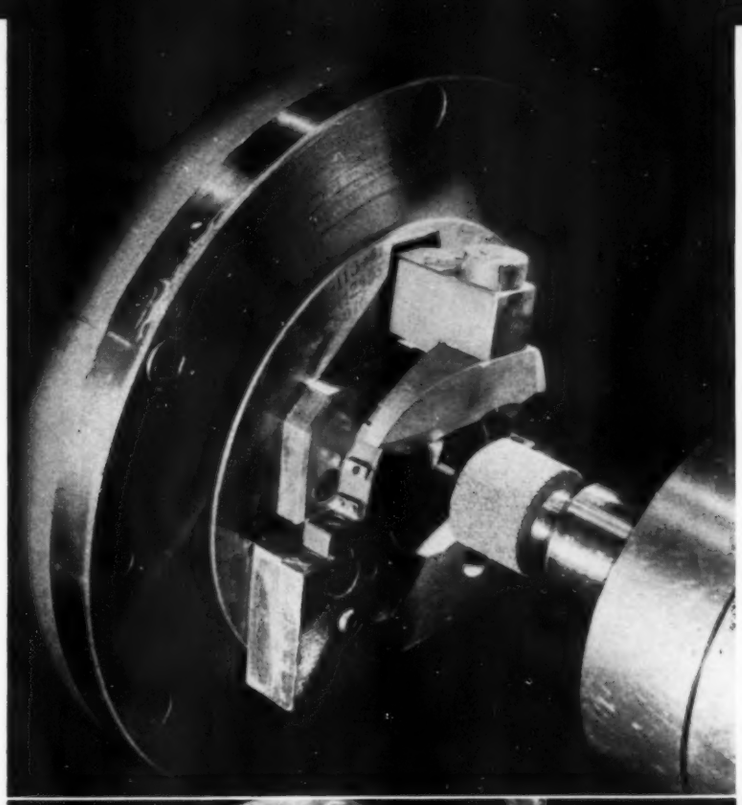
used to advantage for operations requiring a fine finish in the hole. Steps are never more than 0.005 in. on the diameter. In some cases two steps are used on reamers where a relatively large amount of material is to be removed from the hole.

Coolant is used to advantage in drilling and tapping steel parts. This is flooded on the work. A different coolant is used for each of the two operations.

MULTIPLE-SPINDLE SENSITIVE *machines are used for a number of drilling and tapping operations. A terminal board of bakelite, having 680 regularly spaced holes is drilled at the rate of 150 pieces per 8 hr. day, using 20 small chromium-plated drills and indexing 35 times. A set of 14 No. 5-40 taps, used in a similar machine for tapping ⅛-in. thick Norway iron, has exceeded 87,000 holes per tap without grinding*



EFFICIENT TOOLS *and solid spindle construction permit accurate drilling at high speeds. All drills are sharpened in the tool-crib, which insures accurately ground drill points at low cost*

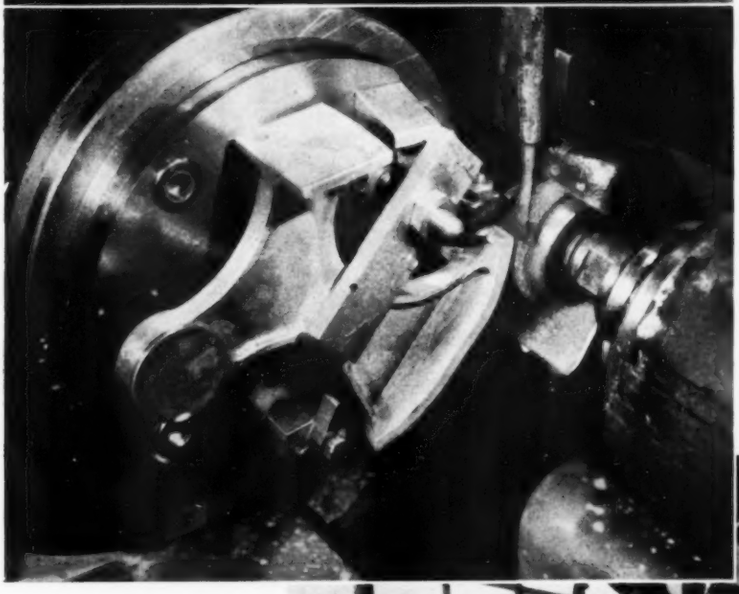


WORK-HOLDING FIXTURES *facilitate internal grinding operations. This molded part of No. 56 Colasta, having eleven steel inserts projecting into the bore, is ground from the rough with a No. 80K carborundum wheel*

GRINDING

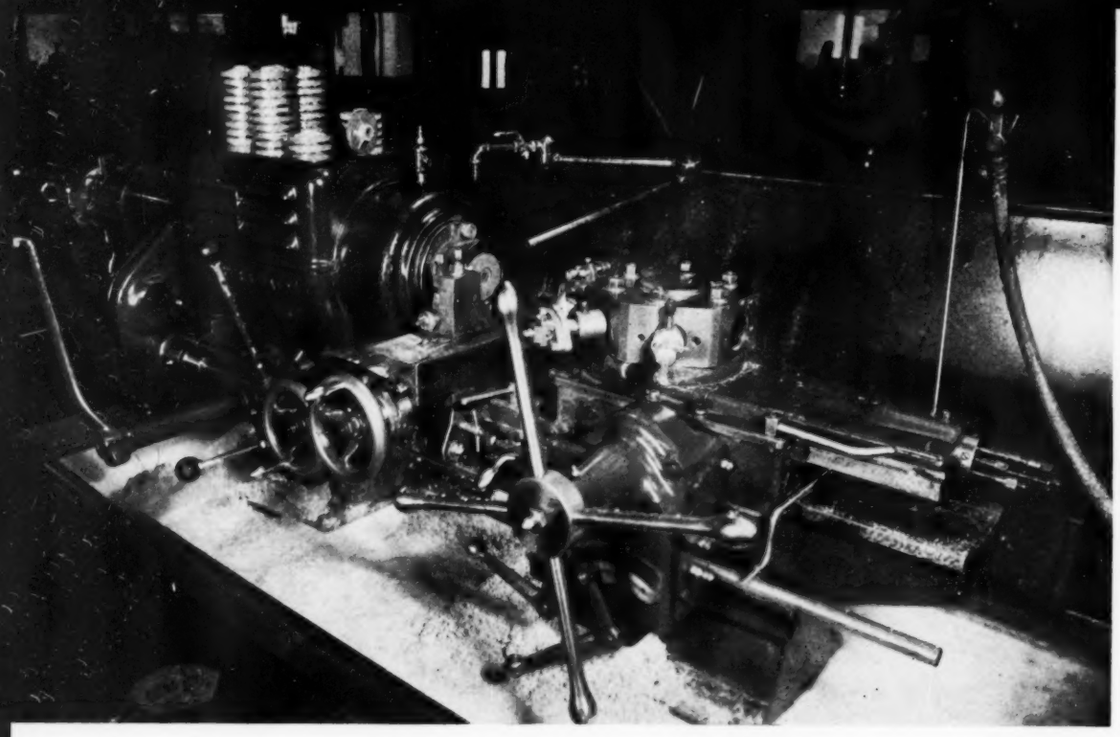
SURFACE, internal and external grinding operations are performed on a wide variety of parts and materials. Production quantities are, in most cases, relatively large and grinding tolerances of ±0.0005 in. are regularly held. Many surfaces are ground to tolerances of ± 0.00025 in.

Usual practice is to use wheels at 5,000 to 6,000 surface ft. per min. with rapid traverse and light feeds.



BRASS PENDULUM LEVERS *have a double radii ribbon cam track. This surface is rough ground to +0.002 in. and then finish ground to ±0.00025 in. One radius is finished to 3.1250 in., the other to 2.2692 in. A special fixture is mounted on a Norton cam grinder. Finish grinding is done with a 2.375 ±0.010-in. diameter wheel*

BOTH HORIZONTAL AND VERTICAL *spindle surface grinding machines are used for surface finishing many of the parts. Wheels are carefully selected for the work being done*

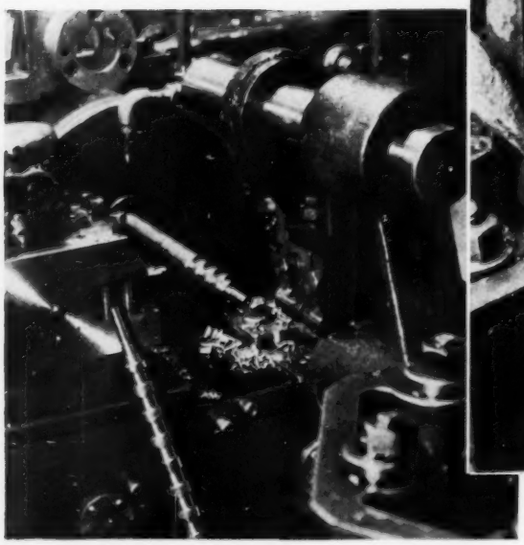


DIAMOND TOOLS *face and bore 550 molded Colasta circuit breaker cams in 8 hr. The high speed No. 2 Warner & Swasey turret lathe operates at 3,600 r.p.m. for the facing and boring operations and at 1,800 r.p.m. for reaming the 0.500-in. hole*

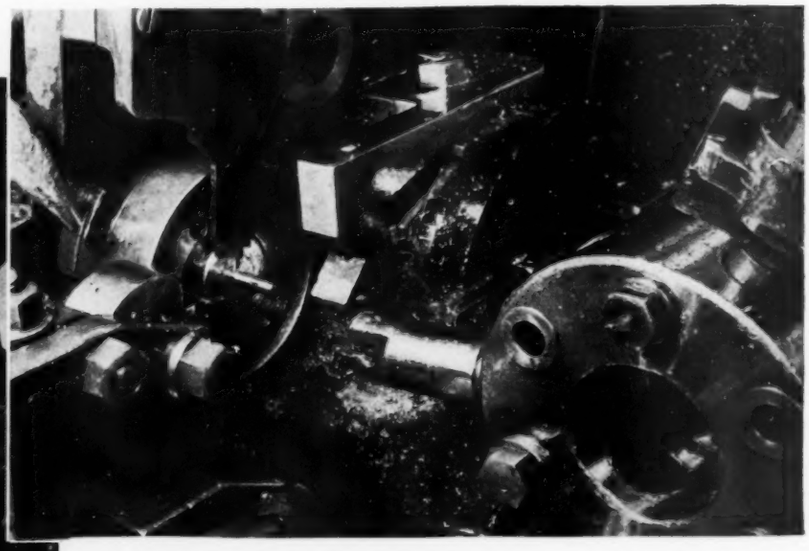
TURNING

HIGH machine speeds prevail in screw machine and turret lathe operations as in other parts of the shop; S.A.E. 1010 and S.A.E. 1015 steels are regularly turned at 220 to 250 surface ft. per min. Fine feeds and high spindle speeds are found to give best production with required close accuracy and fine finish.

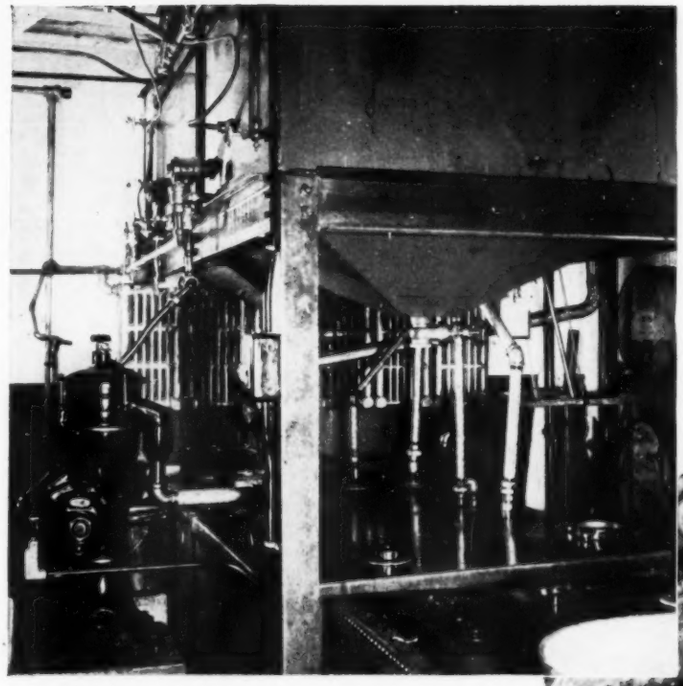
As a general rule one operator takes care of three automatic screw machines. This arrangement has reduced idle machine time by 50 per cent. Six or seven screw machines were formerly assigned to each operator.



FEED ROLLS *for the tabulating machines are form turned from 15/16 in. diameter cold drawn steel rod at the rate of 72 pieces per eight-hour day. Box and cutoff tool work is done with the spindle turning at 800 r.p.m. Two form tools, one for each half of the length, cut the grooves at 216 r.p.m.*



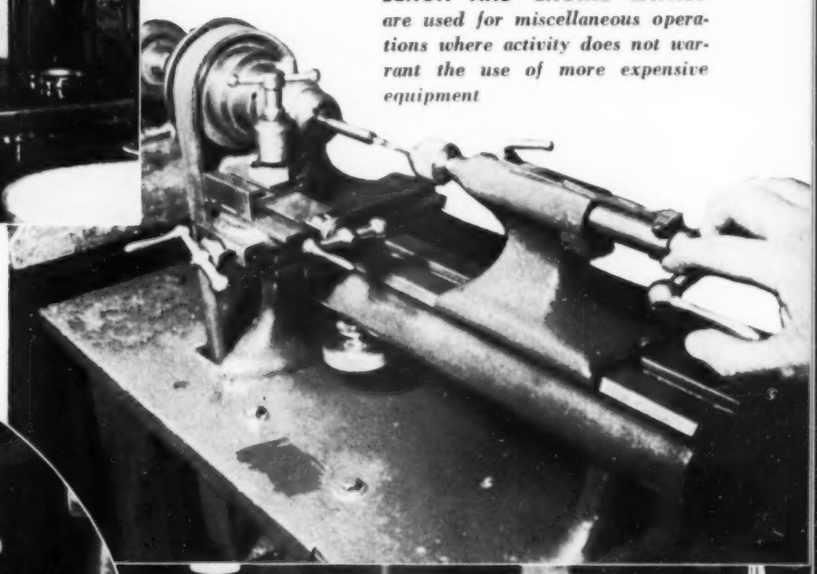
CARD BRUSH CLAMPING SCREWS *are pierce punched, threaded and cut off from 3/32 in. brass rod at the rate of 900 pieces per hr., using a No. 0 Brown & Sharpe screw machine. Spindle speed is 1800 r.p.m. The 0.038 x 0.140-in. punch is carried in the front slide, and piercing is done with the spindle stopped*

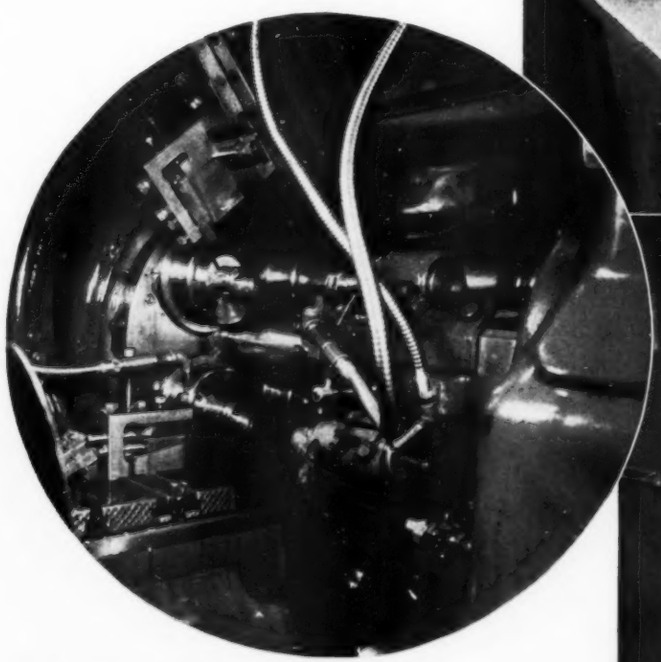


COOLANT *used in turning operations is centrifugally cleaned and filtered before re-use*

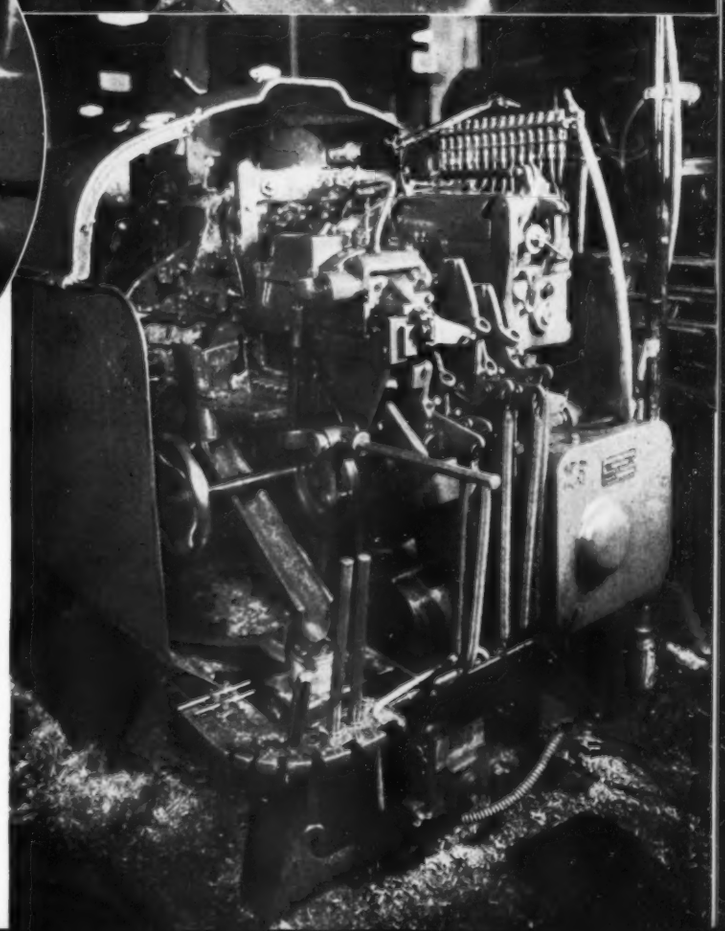
BRUSH GUIDE ROLLS *are grooved with a Carboloy tipped tool in a No. 2 Warner & Swasey turret lathe. These Grade XX Bakelite rolls, molded on a steel shaft, are cut at 1,200 r.p.m.*

BENCH AND ENGINE LATHES *are used for miscellaneous operations where activity does not warrant the use of more expensive equipment*

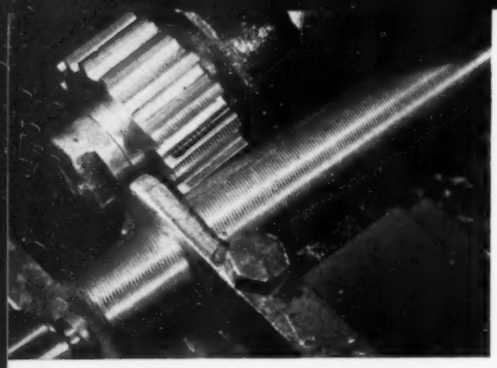




COLD-DRAWN STEEL GEAR BLANKS, ⅞ *in. long, are turned, drilled, bored, reamed, faced and rough and finish formed from 2-in. stock at 430 r.p.m. Production is 109 pieces per hr. A four-spindle Acme-Gridley of 3½-in. capacity is used*



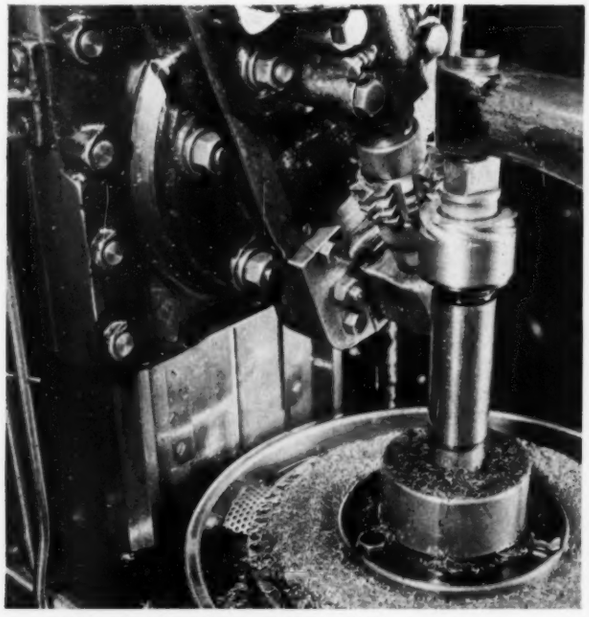
A FIVE-SPINDLE DAVENPORT AUTOMATIC, *formerly operated at 2,400 r.p.m., has been re-geared for operation at 3,700 r.p.m. Brass plugs for the multiplying punch are now drilled, form turned, shaved, re-drilled and cut off from ⅛ in. hexagon stock at the rate of 3,600 pieces per hr.*



THREAD MILLING *of this beryllium copper contact roll was improved by cadmium plating the roll. A 0.001 m. plate increased production from 8 to 60 rolls per cutter grind*

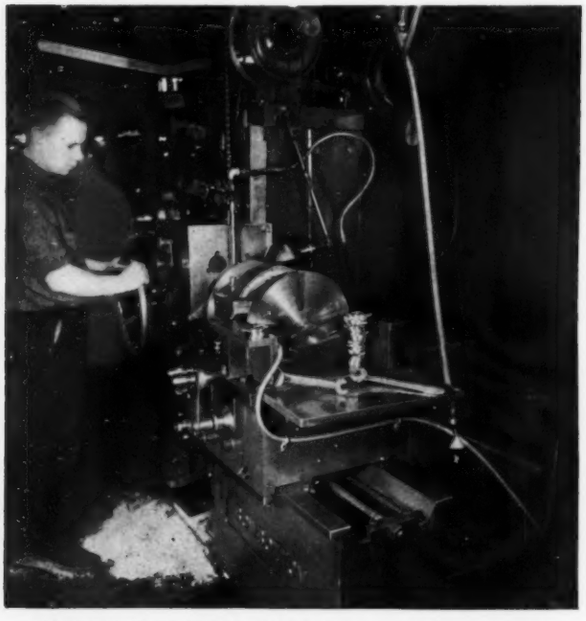
HOBBING AND MISCELLANEOUS

GEAR HOBBERS and cutters of several types are used for machining all gears used in the various I.B.M. products. Clutch parts and program clock disks are also cut on gear cutting machines. Two milling machines are used for the wide variety of plate and face cams. Rack cutting machines are installed for slot milling type bars and similar parts where production requirements do not justify the expense of cutter gangs.

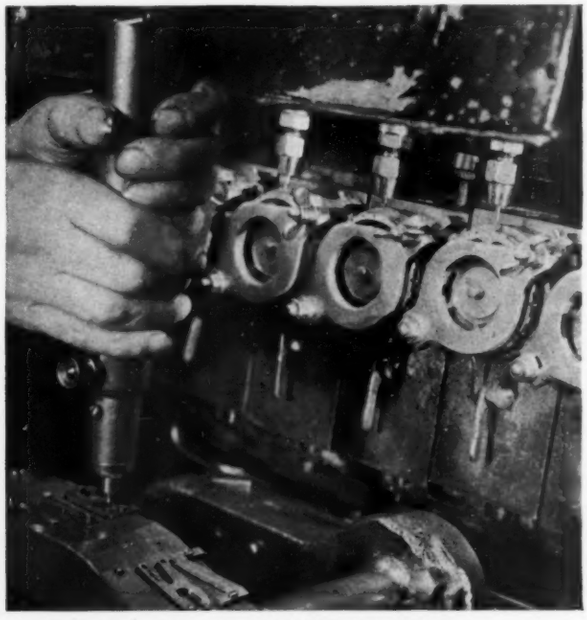


SPUR AND HELICAL GEARS *and worm-wheels are hobbed to close limits of accuracy and finish. Maximum capacity is 18-in. diameter and 12-in. face*

GEAR HOBBERS AND CUTTERS, *of both horizontal and vertical spindle types, cut all gears used in I.B.M. products*



ROWBOTTOM CAM MILLERS *are used for most of the plate and face cams made at Endicott. Bells warn the operator when a cut is completed*



MOST DAY AND DATE PRINTING WHEELS *are die-cast. Wheels having a low activity are cut in swing-type engraving machines.*

OFF THE PRESSES

Coining and shaving have been brought to a high state of development at I.B.M.

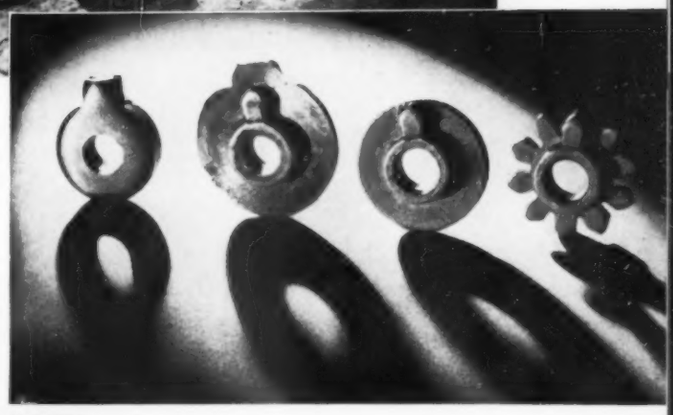
BUSINESS MACHINES lend themselves in large measure to fabrication by press work. The duty required of any of the maze of mechanisms is slight, but the accuracy and dependability must be very high. Sheet-metal parts fabricated in press tools provide the answer where uniformity, lightness and ability to go in small space are the principal requirements.

Nearly all common press operations except drawing are done; that is, blanking, forming, piercing, shaving, upsetting, swaging and coining. Some of the shaving and coining jobs are unusual, and examples will be described later. Presses employed vary in size from bench models mounted on legs to 400-ton coining presses and multi-slide machines.

A JOB-SHOP SET UP

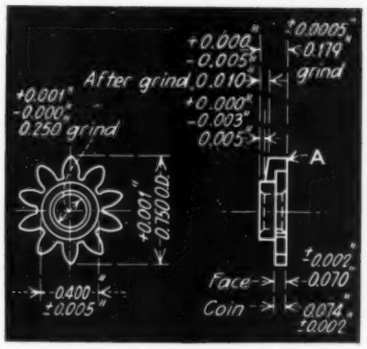
One of the major problems involved in the operation of the press department is the variation in kind and quantity of parts processed. These range from those small enough so that several hundred pieces can be made from 1 lb. of stock up to parts where a single piece will require 2½ to 3-lb. of material. Variation in quantity ranges from lots of 100 pieces to parts made in lots of 250,000 pieces. This problem might also be illustrated by stating that nearly 6,000 different kinds of parts, all of which are active, must be processed on a group of 35 presses. Recently in one day's run a total of 749,000 different pieces passed over these presses. In an 80-hr. period a total of 760 different jobs were set-up. The problem is further complicated by the fact that it is customary to order parts four times a year, based on normal requirements for three months.

All types of dies are included among the 15,500 maintained in die storage. These dies range all the way from multiple-station dies, making parts complete in one operation, down to Continental dies of the simplest type. Most of the dies, however, are mounted on die sets even where the production is relatively limited. There are two reasons for this; (1) most of the parts require real accuracy not obtainable with loose dies, (2) set-up time must be held to a minimum due to the num-

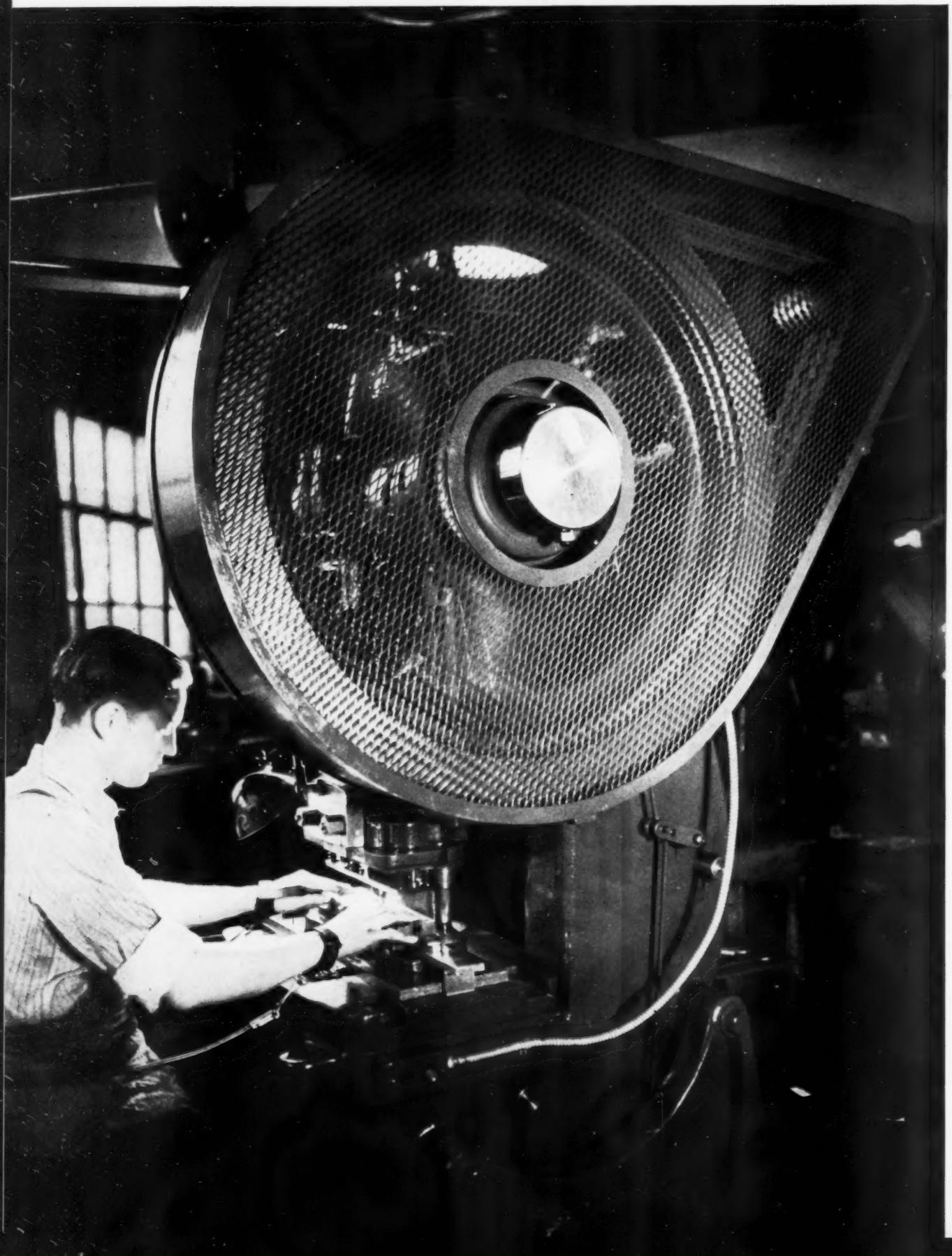


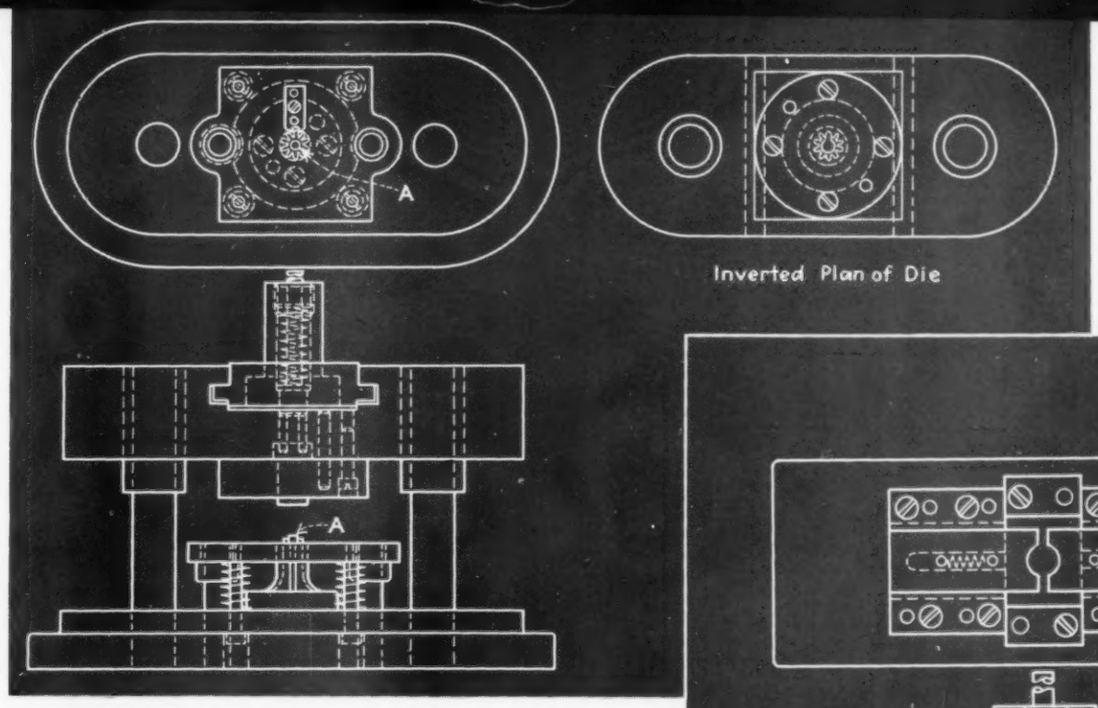
COLD COINING *produces a hub and an extra-thick tooth in this reel counter wheel*

THREE SHAVES *are required to get the accuracy and finish required on the teeth*

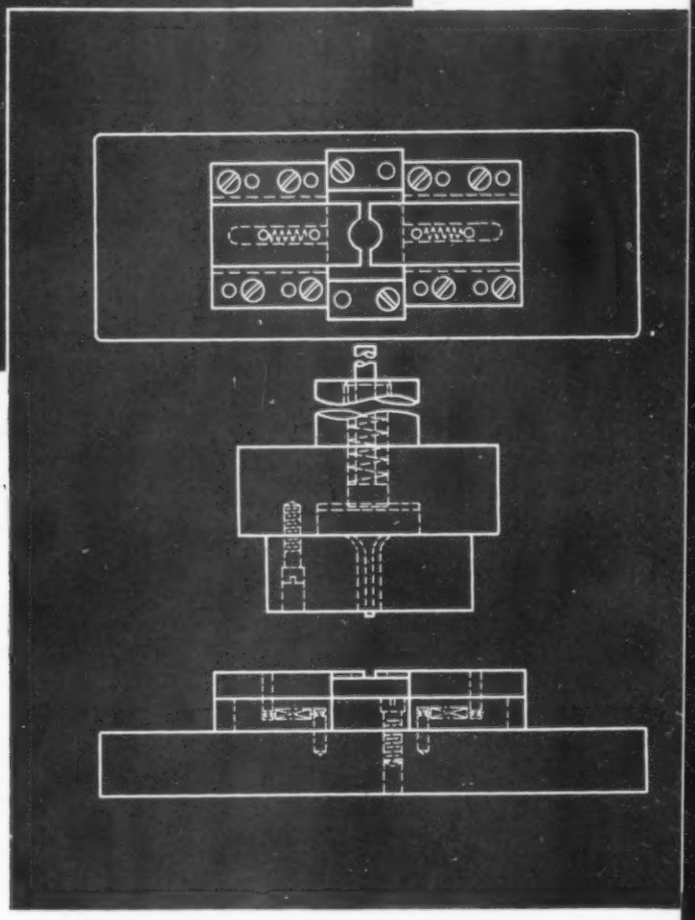


PRECISION DIE SETS *are used for the majority of 15,500 dies in order to save time in set-up and to insure the requisite accuracy*





A SHAVE DIE *for the reel counter wheel has the punch at the bottom. Note the flexible connection of die set to press ram*



AFTER PIERCING *and blanking the piece is laid in the nest and coined*

ber of set-ups involved in the shop.

Many of the parts made in the press department require shaving. Some of these are shaved once, others twice and a few three times, depending upon the finish and accuracy required. Most of the shaving dies are of the inverted type with the die above, to allow the chip or shaving to drop out. In the construction of shaving dies, I.B.M. specifications indicate that all dies must be ground or stoned free from all file marks. This is to insure proper quality of finish on the product.

Shaving dies must also be mounted on die sets provided with a floating holder. This provides a flexible connection to the ram of the press and eliminates any inaccuracy in the alignment between punch and die which might result from inaccuracies in the press itself. These die sets are of the precision type with extra long ground bushings for the leader pins.

EXCEPTIONS TO SHAVING

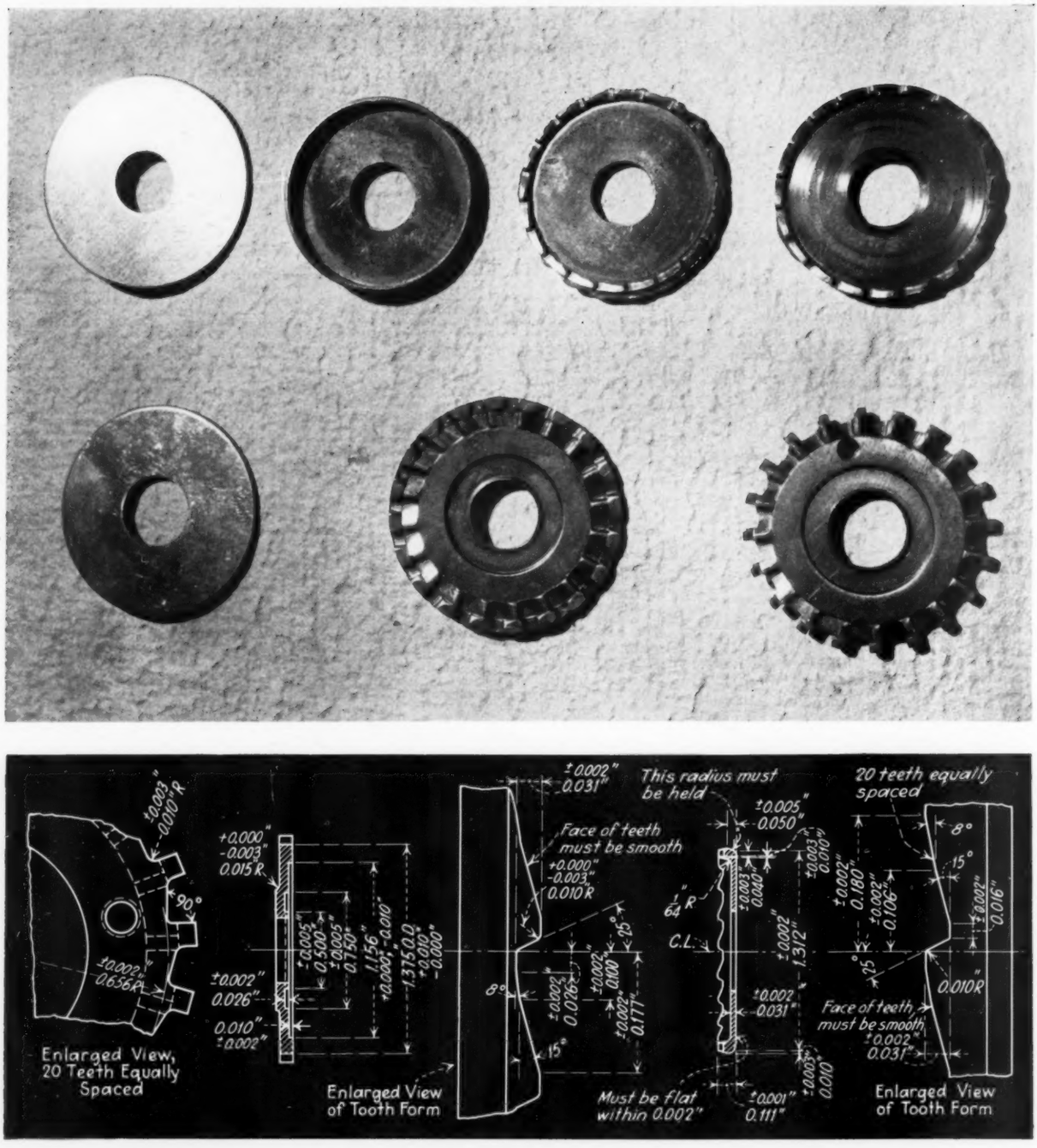
While shaving is the accepted method of finishing all of the parts which originate in the press department, there are e ceptions to this practice because of materials used in the production of parts which are subject to severe usage. The materials which do not permit the use of shaving operations are certain types of alloy steel, such as SAE 3115 chrome nickel and cold-rolled tool stee's. It is impossible to get the proper quality of finish on steels of the type mentioned and therefore broaching is substituted for shaving. The broaching is done in another department.

The press department is equipped with machine and bench equipment for finishing parts which originated in the department. This equipment consists of two 4-spindle drill presses, tumbling barrels, disk wheels for burring and bench equipment for straightening. This policy permits finishing a large number of the parts complete in the department and reduces the handling and movement of material.

This department is a!so equipped with surface grinders, bench lathes and bench millers to permit the making of minor repairs and sharpening of dies in the department. This is done to eliminate the handling of tools and increase operating efficieney. All major repairs, however, are sent to the toolroom. In going to the toolroom all dies clear through the tool inspection department, where a record is kept of the condition of the die and instructions prepared for the guidance of the tool room in making the repair. When dies are returned to the press department, they are also cleared back through the tool inspection department and an accurate check is made of the condition of the die before it is forwarded to the press department. In the event of errors the die would be returned to the toolroom for correction before delivery to the press department.

MATERIAL CONTROL

The materials required for making punch press parts are kept to a minimum, both for kind and size. Proper methods of control have been established in the production engineering department to insure specification of proper kind of material


Enlarged View, 20 Teeth Equally Spaced
Enlarged View of Tooth Form
Face of teeth must be smooth
This radius must be held
Must be flat within 0.002"
20 teeth equally spaced
Face of teeth, must be smooth
Enlarged View of Tooth Form

COINED TEETH *in halves of an alphabet printer have been made in experimental press tools. Previous method of producing ratchet and clutch teeth by hobbing is much slower than cold coining. Intricate coined shapes can be successfully produced as proved by the dimensions*

and to eliminate unnecessary kinds and sizes. At present, materials which are in use are as follows: SAE 1010 cold-rolled strip with three hardness ranges, medium and high-carbon steel (cold-rolled steel), SAE 3115 and SAE 3140 chrome nickel steels, 18-8 stainless steel, brass in three tempers and beryllium copper. Most of the material specified is SAE 1010. In purchasing this material the hardness range is specified in order to get closer control for forming and shaving. Rockwell B 92 to 105 is used principally for straight flat blanks where good blanking and shaving properties are of maximum importance. Rockwell B 75 to 90 is specified for blanks requiring 90-deg. bends or forms. Rockwell B 66 maximum is specified for severe bends, swaging or coining.

One of the most interesting coined jobs is the reel counter wheel which is illustrated in various development stages. The principal operations, including all those done on presses, are as follows (1) pierce and blank, (2) coin hub and teeth in carry position—the extra-thick tooth, (3) trim O.D. round, (4) a screw-machine operation follows, using a magazine feed to size the hole and

square the back, (5) trim teeth, leaving oversize for shave, (6-7-8) shave in three steps. For operations 5, 6, 7, and 8, each die is produced with a set of three broaches. Thus, the parts are always interchangeable and the cost of making new dies is much reduced.

Dimensions of the wheel are also given. The pierced and blanked part is laid in the spring-actuated nest of the coining die and mashed down to form the hub and the extra-thick "carry tooth". The material is SAE 1010 steel, with a Rockwell hardness of B 66 maximum. The thickness is 13/64 in.

THREE-STAGE SHAVING

Shaving of the reel counter wheel is done in three stages in tools such as shown. Each shave takes off 0.001 in. of material and the final tolerance is ± 0.002 in. at the pitch line. The dies are of the inverted type. A hardened locating pin *A* is driven in the punch and fits the hole in the wheel. When the part is placed over the pin, it is also located from the same tooth as used for location in the trim die.

Clutch parts are now being made on an experimental basis by means of cold coining. Production methods for cutting these teeth up to the present time have involved the following. The stationary flat half of the clutch has the escapement teeth cut on a Barber-Colman machine, and the clutch teeth are cut on a Waltham bench-type pinion cutter. The movable cup-shaped part of the clutch has the clutch teeth cut on a Waltham machine. It has been demonstrated that coined work of the required accuracy can be produced and dies are now being developed.

The stationary half of the clutch is to be made by the following operations: (1) pierce and blank, (2) coin complete on 400-ton press, (3) trim ratchet, leave stock to shave teeth, (4 and 5) shave ratchet teeth to size, (6) pierce small holes in relation to ratchet teeth and center holes. Dimensions are given on the coined ratchet clutch teeth to show the accuracy demanded.

Operations on the movable half of the clutch are: (1) pierce and blank (2) cup, (3) coin teeth and set radius on bottom, (4) shave flash inside and outside, (5) pierce three notches around hole (not shown in photograph), (6) shave notches. The coining dies are built so that a radius is set into the bottom of the cup.

This particular coining job shows the energy of the manufacturing engineers' department in searching out jobs that can be done more cheaply and quickly. In this case there is no comparison between the output of the part by the previous hobbing method and by the contemplated press method.

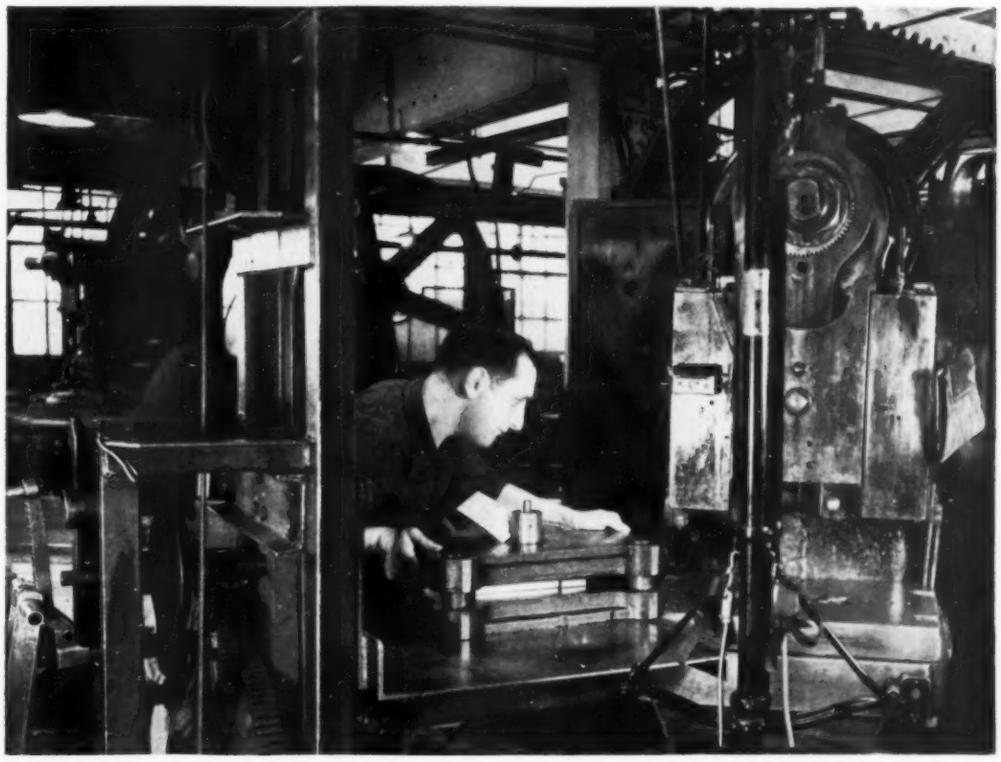
The I.B.M. press shop has many other examples of unusual coining and swaging jobs. The two described, however, should show how small parts can often be made on presses to advantage.

INSIST ON SAFETY

Safe operation of all press equipment is insisted upon by the management and safety rules are rigidly enforced. All presses are equipped with safety devices. Those presses which are used exclusively for secondary operations are equipped with the Possons safety device. This device is arranged with cuffs which the operator wears on his wrists. Cables attached to these cuffs pull the operator's hands back out of the way of the dies if he neglects to remove his hands before tripping the press.

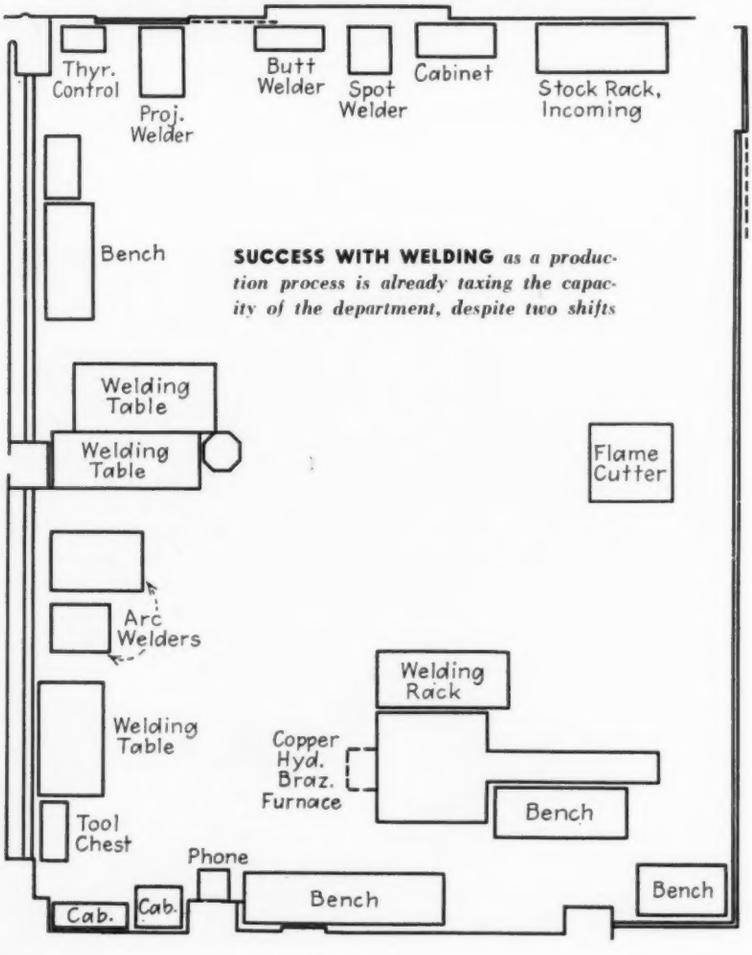
Sheet metal guards are provided on all blanking dies, making it impossible for the operator to enter his fingers between the punch and die.

The record of this department for the past two years and five months shows that a total of 244,000 man hours have been worked without a lost-time accident due to machine operations.



SET-UP TIME *allowed for large presses is usually ¾ hr.; for small presses only 0.2 hr.*

MACHINE TOOL ACCURACY *was demanded of this projection welder, necessitating extensive alterations. The operator controls the cut-off of the welding current to within one cycle*



SUCCESS WITH WELDING *as a production process is already taxing the capacity of the department, despite two shifts*

WIDER SCOPE FOR WELDING

Two years ago a welding department didn't really exist. Now it uses a variety of processes, is reaching out for an ever-increasing share of the plant's production load

THREE YEARS ago I.B.M. took steps to make welding play an important part in its production processes. A welding specialist was attached to the manufacturing engineer's staff and told to go ahead. He found that welding was confined then mostly to maintenance work, although there was a spot welder doing an occasional production job. Two or three men comprised the entire working force at that time. Now fourteen men are working in two shifts. The processes used are: spot and projection welding, butt welding, arc and gas welding, flame cutting and brazing.

Expansion of the welding department has proceeded on carefully thought-out lines. It is today a job shop doing hundreds of different production operations, many of which require extreme accuracy in the welded assembly. Flexibility in operation must be secured because so many jobs are coming to the department that it is hard pressed to handle them all. Where fixtures must be used, as in spot and projection welding, they are designed to save time as much as possible. It is considered better to spend money on good fixtures than to fuss around and hold up production with a poor set-up.

The projection welders on the market did not appear satisfactory to the manufacturing engineer's department, considering the accuracy and fragility of the work. Therefore, extensive modifications were worked out in connection with the builders of the National welder to provide a machine of real machine-tool accuracy. A 200 Series press welder was built with an extra-long ram guided in an extra-long precision slide with gibs to take up wear. The upper and lower platens are parallel with each other and at right

angles to the ram to as close limits as possible in working with the nonferrous material of which they are made. T-slots in the upper platen allow for quick set-ups of different projection welding dies.

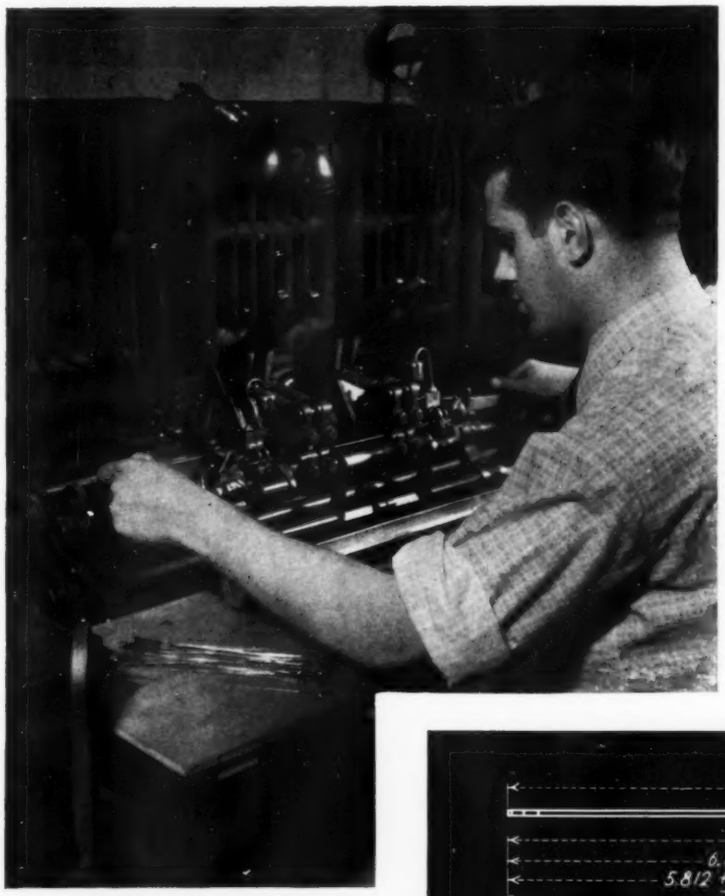
This press welder has many other features that provide the utmost in efficient "fingertip" control. The welding control is entirely automatic and the welding time can be controlled to as close as one cycle. Current input is practically infinitely variable because of the special transformer applied, thereby affording just the right amount of heat. The locked air cushion for the ram applies constant pressure during welding despite variations in line pressure. A gage at the top is calibrated to read the actual ram pressure, not the air line pressure. Speed is not special, the strokes ranging from 15 to 95 per min.

Each time a job comes to the press welder, the operator refers to a Kardex file of operation cards. These give the correct data concerning transformer setting, ram pressure, and number of cycles for the welding current. The last is set on the dial at the left.

A typical projection welding job will show what can be done with the right combination of accurate machine and accurate fixture. The assembly consists of a rack, a stainless steel strip with blanked-out openings and four cadmium-plated cross pieces. Cadmium plating is 0.0003 in. thick, and is required for corrosion resistance of the cross bars. Despite the adverse effect of this plating on making good spot welds, the technique developed gives a 100 per cent perfect job.

JUMP-WELD FIXTURE

The fixture is a typical jump-weld type in which the rack is laid at the left, the stainless steel at the right, and overlapping the rack for a short distance. The cross pieces are laid in the nest under the stainless steel strip. Rack and cross pieces constitute the negative side electrically, while the stainless strip is on the positive side and touches these parts lightly by means of the ten projec-

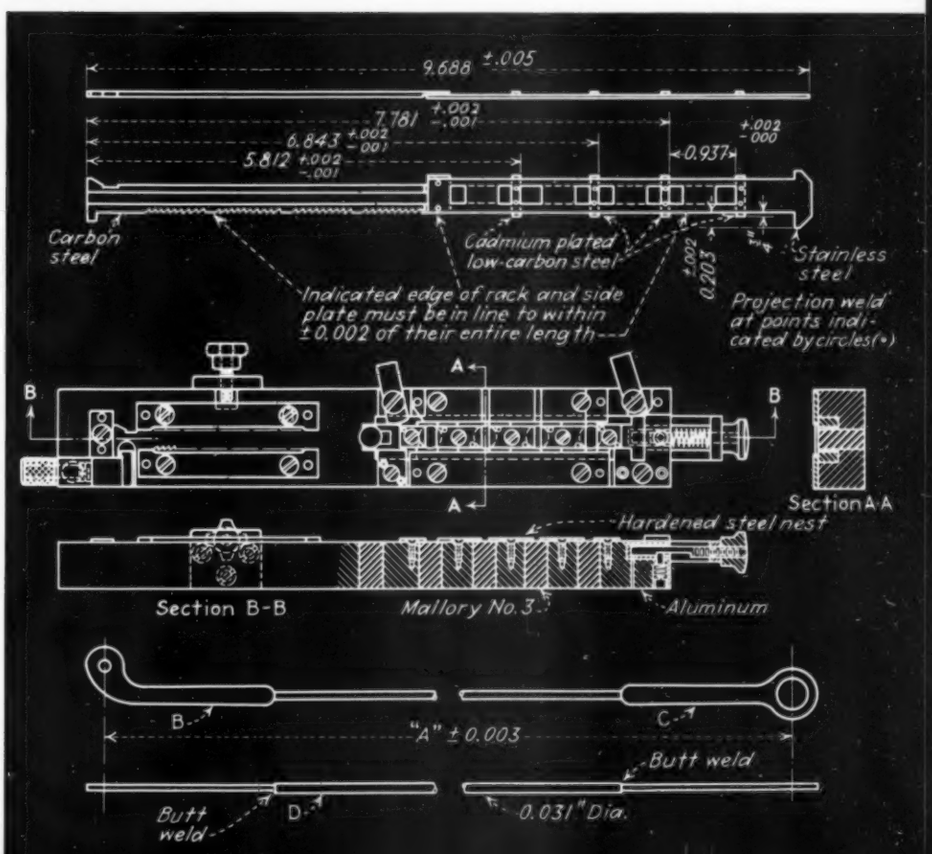


FOUR HOLDING BLOCKS *are required for butt welding the pull-wire assembly. The inner pair of blocks hold the wire, while the outer pair are hydraulically actuated for the butt-welding operation*

CLOSE LIMITS *are placed on alignment of the rack and side bar in the projection-welded assembly, upper right; also for the spacing of the cross bars*

A JUMP-WELD FIXTURE, *right center. holds the assembly while five projection welds are made, commencing from the right end*

IN PULL-WIRE ASSEMBLIES, *lower right, dimension A must be maintained within ±0.003 in. in the butt welding of terminal pieces B and C to the music-wire connecting piece D*



tions put in during stamping. The cross pieces are projection welded to the stainless strip in sequence, commencing at the right. Two spots are put in by the dies and then the fixture is moved over one position. The rack is the last to be welded in place.

This fixture is a good example of the intricacy required in such work. It is complicated not only by the many pieces to be assembled, but also by the accurate adjustment required on these pieces, and by the necessity for proper insulation of the components, to insure that the electrical currents follow the desired paths.

MAGAZINE FEEDS

Tool expense is predicated on accuracy and production desired. Two semi-automatic fixtures with magazine feeds represent the greatest outlay. These are unusual in a job shop, although common in mass production of radio parts. Production averages 900 pieces per hr. with ¾ hr. allowed for set-up. Other fixtures range down in cost to two or three dollars apiece. In all cases, accuracy is the prime consideration.

An unusual butt welding job is responsible for the design and installation of a special machine also of National make. This machine welds two annealed spring-steel terminals to a piece of music wire. Both materials run about 0.95 C. Two conditions must be met: (1) a good butt weld, (2) accurate spacing of the holes in the terminals. Over-all length between terminal eyes must be held to ± 0.003 in. A special gage is used to insure accurate set-up before going ahead with the job. This gage consists of a pin for one end of the pull wire, and a group of pins at the other end to take the opposite terminal for pull wires of different lengths.

The special buttwelder has two movable terminal blocks, actuated by oil pressure working against a spring. Thus, terminal blocks are moved in at an exact predetermined rate judged best for the condition at hand. Near the end of the stroke, the valving is such that the terminal blocks jump ahead with a snap action, giving a final upset to the welds and insuring good fusion. Precision screws adjust the position of the movable terminal blocks. Stationary blocks hold the wire. All four blocks are closed and opened by quick-action clamps.

Arc welding is applied to machine frames, jigs and fixtures and to miscellaneous work. Gas welding is done on the outer corners of sheet-steel cabinets for the sake of appearance and is also used for building up parts, and reclaiming parts for production. Brazing is done with the oxyacetylene flame.

Flame cutting is just being introduced for cutting out gear blanks and cams. An Omnigraph outfit with a cam-cutting device as well as a hand tracer allows a wide range of work to be done. Fourteen gear blanks can be cut out in 20 min., allowing 6 min. for set-up. Each blank is 18 in. in circumference and the stock used is 7/16-in. hot-rolled steel. Many additional jobs will be put on this flame-cutting machine as fast as the necessary changes in procedure can be worked out.

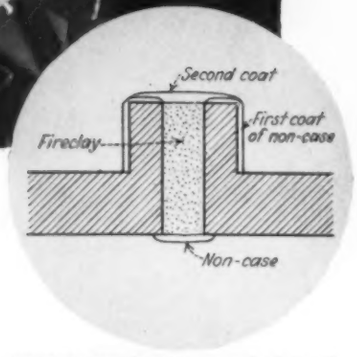
COPPER-WIRE COLLARS

Copper brazing is employed for many assemblies of hubs in levers and similar pieces. These parts are hand fed through a General Electric brazing furnace with standard control. Here also job-shop conditions prevail. Some parts are painted with a special copper paint, but the majority use a copper-wire collar around the hub.

An interesting practice has been developed to make correctly proportioned copper rings that will fit around a hub and supply just enough material to fill the joint. An excess would make for a sloppy-looking piece of work and would be out of harmony with the other work turned out in the I.B.M. plant. Thus for each job the wire gage and the ring diameter are selected to give only sufficient material in each ring to make a proper joint. The wire is coiled on a mandrel of the correct diameter and cut off to the correct length of loop.

GEAR BLANKS *and other parts are being flame cut from hot-rolled plate*

SELECTIVE CARBURIZING *of gears and stub shafts is conveniently done by coating the portions to be left soft with Non Case paint*



MOIST FIRECLAY *is packed in the bore to save Non Case and time*

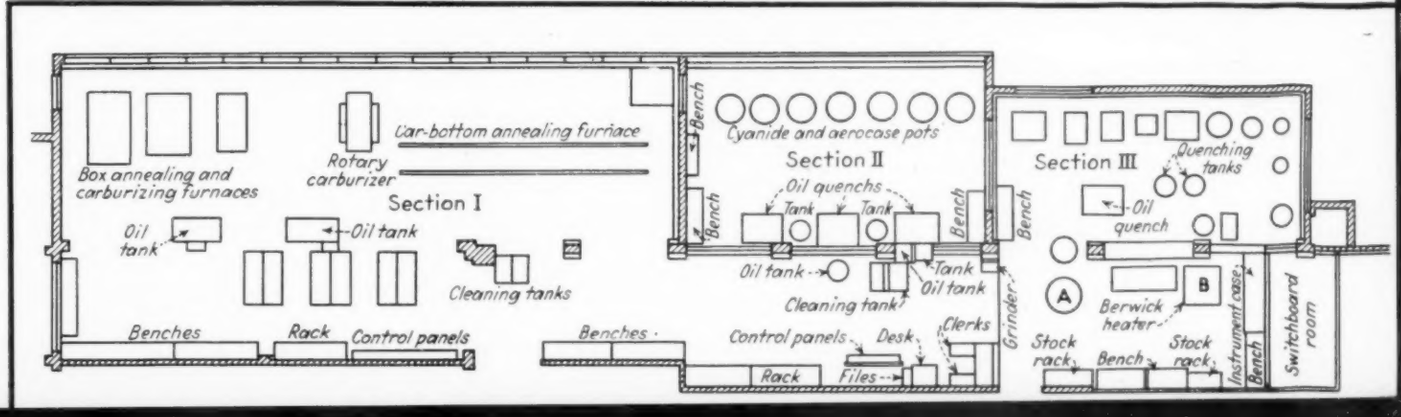
SELECTIVE HEAT-TREATMENT

Production delays are minimized by segregating the department's operations according to size, nature or case requirements

FEW departments or processes "stay put" at the Endicott plant. Heat-treating is no exception. Despite rearrangement of the equipment and an expenditure of $20,000 for new furnaces within the last two years, more new equipment is now being installed and new jobs and processes are being considered.

For convenient segregation of the various types of work done, the department is sub-divided into three main sections. See the floor layout. Long-cycle operations such as carburizing and annealing of castings and electrical iron are carried out in Section I. The carburizing work done here involves parts which re-

BULK OF THE WORK *flows through Section I—carburizing, Section II—Aerocase treatment, Section III—tool and parts hardening, but newer applications of heat involve tempering of beryllium copper and annealing of rivet tenons at points A and B*



TENON ENDS *of some rivets are annealed by electric heat*

SPECIALLY BUILT *slides are necessary in this Berwick electric heater to afford accurate electrode movement in annealing rivet tenons*

quire a deep case and those whose size or shape does not permit Aerocase treatment.

One of the box furnaces in Section I is being replaced because modern furnaces of latest design and with the latest refractories conserve enough heat to pay for themselves in a short time. In fact, if it can be definitely shown that a new furnace will pay for itself within a year, steps are taken to procure it immediately. This practice is in line with the standard I.B.M. policy at the present time.

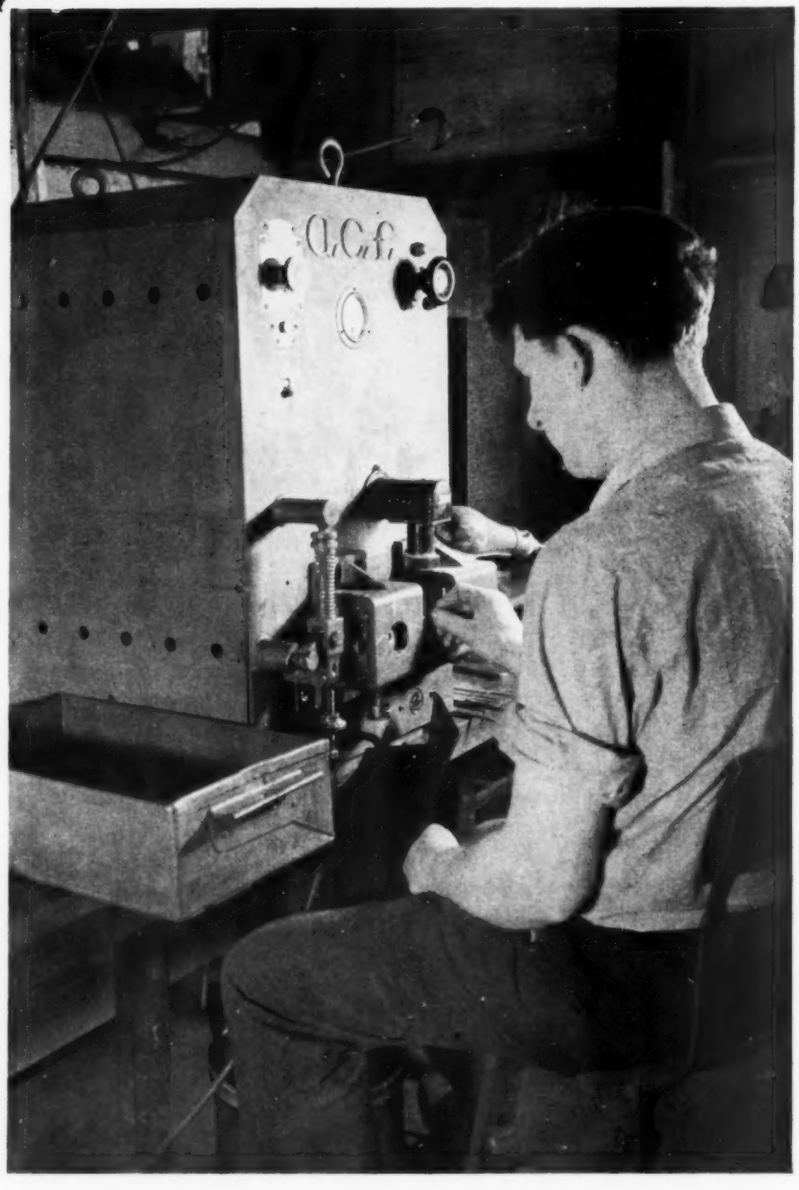
TWO CARBURIZERS

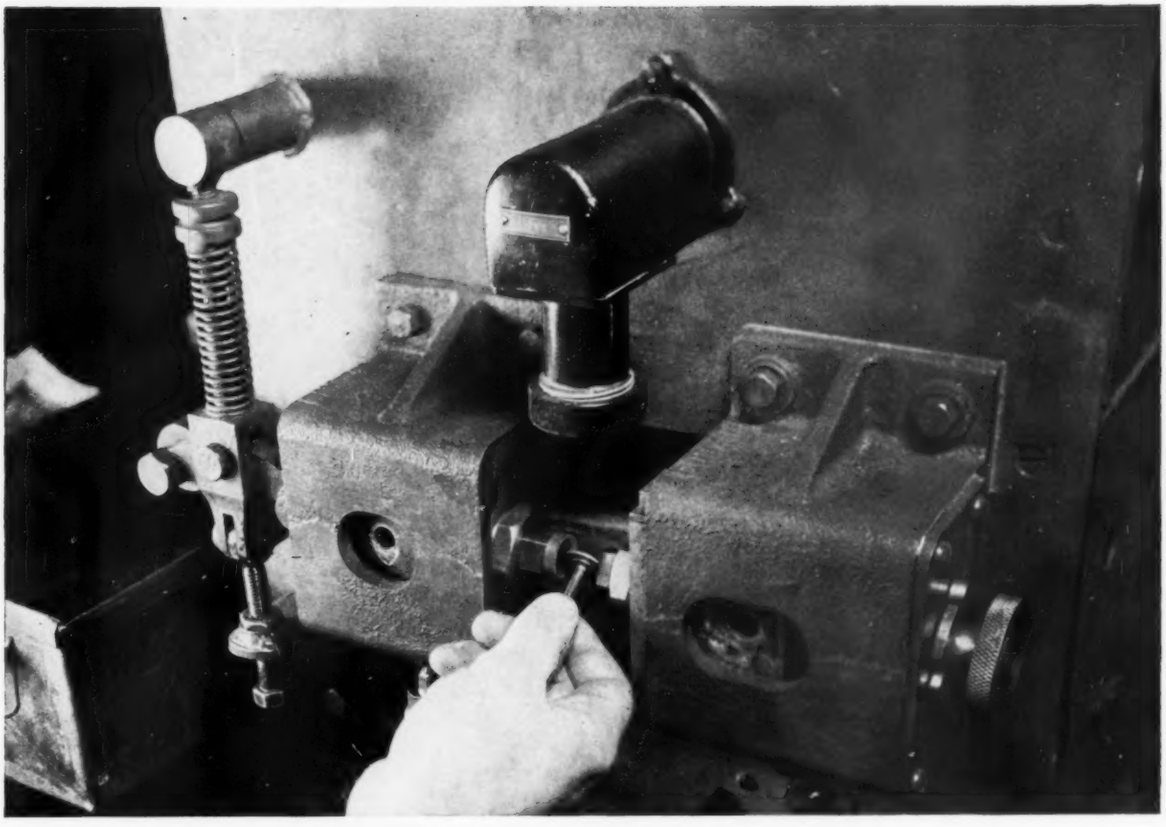
Two different carburizing materials are in use. One is a solid nonburning material. It contains an energizer to speed up carbon penetration, but cannot be used on copper-plated work. The other material is a special compound that will not attack copper-plated work.

Many of the parts to be carburized in Section I have portions that must remain soft. Examples are the bores and hubs of small gears. The volume of work is great enough to keep one man constantly painting "Non-Case" material on these parts. For drying them properly, he has a supply of racks made in different sizes so that the gears of larger diameters can be stood upright. The painted gears are allowed to remain overnight to dry, and are then carburized the next day. No work is done on Friday, because it has been found that work carried over the week-end will develop cracks in the paint upon too long drying. These cracks through the Non Case paint would allow penetration of the carburizing gases.

One kink has been worked out in connection with the painting of Non Case paint on hubs of gears. The operator first paints the hub end and face with Non Case. He then packs the bore with moistened fireclay which is obviously quicker to apply than paint. Then both ends of the bore are sealed with another application of Non Case material. After carburizing it is very easy to remove the Non Case and the fireclay with the fingers. In fact, a good deal of it will break off in normal handling after removal of the pots from the furnace.

Short-cycle casehardening is done in Section II. The equipment here consists of one cyanide pot and six Aerocase pots. The cyanide pot is





ELECTRODES ARE CHANGED *to suit the size or shape of the part to be annealed. These are many times larger than the chisel-shaped ones used for the small rivet tenon illustrated*

used for case depths up to 0.003 in. whereas the Aerocase pots are employed for thicker cases on somewhat longer time schedules.

Section III is reserved for tool hardening. A good deal of the work requiring grinding after heat-treatment is hardened in Lavite No. 130 neutral salt, especially pawls and small high-carbon, tool-steel parts. The salt does not decarburize or carburize and permits scale-free hardening. Material savings are experienced in the grinding department through reduced wheel wear on scale-free work.

BERYLLIUM-COPPER TEMPERING

Two Leeds & Northrup Homo furnaces are installed near the entrance to Section III. The small model is used for temper drawing of tool steel parts, whereas the large Homo is reserved entirely for heat-treatment of beryllium-copper contacts. The contacts are distributed about 1 in. deep on the bottoms of five nested wire trays to assure quick even penetration of heat. The contacts remain in the furnace for 45 min. at 530 F. and are then cooled in air. This treatment provides the proper spring temper. Control strips from each coil of beryllium copper go through the heat-treat and are checked in the laboratory before release for production.

Two of the newest jobs in the heat-treating department are rather unusual. Some of the rivet tenons are not copper plated before hardening because the design of the rivet makes it difficult to load in copper plating trays. Therefore, after hardening these rivets are brought to a special Berwick electric heater for a localized annealing on the tenon end. The action of the heater jaws was not sensitive enough in closing upon these very small tenons. For this reason the rams and bearing surfaces were redesigned to afford smooth steady movement of the electrodes and assure closing to an accurate gap. The setting of the gap is controlled by fine pitch screws.

ELECTRICAL ANNEALING

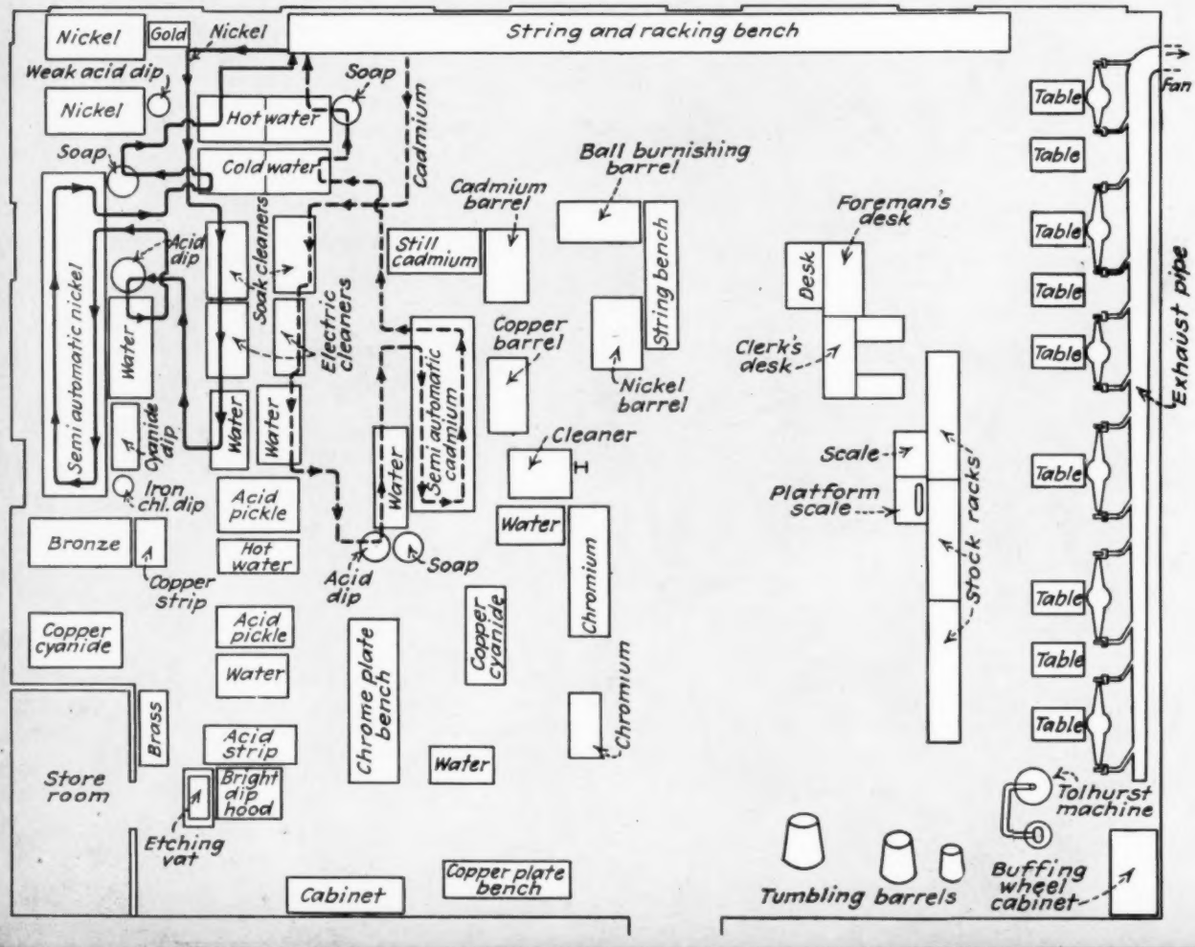
The operator presents the rivets to the jaws one at a time, with the tenon end upright. He then steps on a pedal, the jaws close, they remain in contact with the work for a definite period and then open automatically. Current passing between the jaws and through the rivet tenon causes localized heating and annealing. The body of the rivet remains hard. The operator's coordination of hand, eye and foot is such as to give a relatively high output on what is essentially the placing of a small object in accurate location.

WELD REHABILITATION

The second job has to do with restoring the ductility of welds in pull wires. These parts have two spring steel terminals connected by a piece of music wire. All three parts run about 0.95 carbon and the two welded joints are very brittle and easily broken. To overcome this condition the ends of the pull wires are alternately placed in a small heat-treating bath. The furnace is a Trent ½-kw. bench type maintaining a Lavite salt bath at 1450 F. The operator inserts the terminal end up to the weld through a small hole in the cover for a few seconds, withdraws the piece and quenches the terminal up to the eye section in oil. This treatment restores full ductility in the welded joints and leaves the eyes in a hardened condition to resist wear.

AN ORDERLY METHOD *of racking work instead of wiring has increased production several-fold on this essential operation. Pipe rails A provide storage space for racks; rail B holds the rack at convenient height while putting pieces on the hooks; rail C is used for loaded racks going to or coming from the plating tanks*

PRODUCTION SEQUENCES *for nickel- and cadmium-plated work are traced from the racking bench to the semi-automatic plating machines and back again*



PLATING FOR PROTECTION

Racks save much time over the older method of wiring the work, and also serve to enhance the straight line operation of the department

MODERNIZATION of the plating department has paid for itself in less than two years. Installation of new equipment and rearrangement for straight-line production have increased output and efficiency without adding floor space. It is now evident that the production increase is at least 40 per cent and that operating savings amount to 14 per cent.

These results were achieved by several improvements: (1) replacement of all but two still nickel tanks with a semi-automatic nickel plating unit, (2) replacement of all but one of the cadmium plating still tanks with a semi-automatic cadmium plating unit, (3) installation of an additional chromium plating tank for increased production requirements, (4) installation of two 2,500-amp. generator sets to care for the increased current required, (5) rearrangement of the cleaning line, and (6) provision of suitable racks so that work could be racked instead of being wired on copper wire.

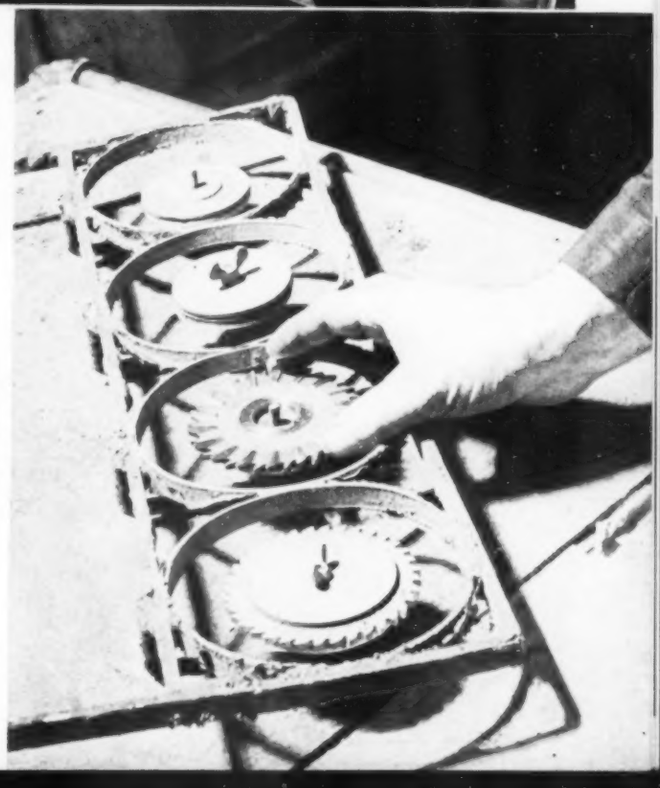
CENTER OF OPERATIONS

It is now possible to show how the system for racking work is making large savings. The string and racking bench is placed along the north wall of the department where ample glareless light is available. Stretching for about 40 ft., this bench is the center of operations for loading and unloading parts going to and returning from the plating equipment.

A definite method is followed in putting the work on the loading racks. There are three long rails above the bench to provide convenient storage for empty racks. Beneath these storage rails is the loading rail from which a rack is suspended at convenient height for the operator to put parts on the hooks or to remove them. Fastened to the bench is the rail for holding loaded racks either going to or returning from the tanks. With this system two men recently handled 6,500 pieces per day, whereas the best they could do with the old method of twisting copper wire on the parts was 1,500 pieces per day.

These racks are not at all of one size or pattern. They are of standard Belke design with rubber-covered frames and are built to take from 32 to 90 pieces, depending on the size and shape of the part. Hooks are readily unscrewed for substitution of new ones.

The plating of tools is one reason why chromium plating is being used



HIGH-LUSTER *and satin finishes are produced in a polishing section segregated from the plating operations. Six metals are plated — brass, cadmium, chromium, copper, gold and nickel*

AN UNINSULATED RING *around each cutter has the effect of distributing the plating current, thus overcoming burning of the cutter teeth*

more extensively in the department. New taps, drills, drill bushings and milling cutters are being chromium plated to increase wear resistance. The life of new taps and drills for Bakelite has been increased fifteen times by a thin plating before use. Cutters with a plating of 0.0005 in. show a life ten times as great as unplated ones. Worn tools are built up to a maximum of 0.001 in.

Cutters are plated in racks in which the size of the holders and number of them per rack varies with the size of the cutter. Each holder consists of a disk and stud, a washer to hold the cutter in place and a wing nut. Each holder is surrounded by an uninsulated ring which has the effect of balancing the electrical current in the electrolyte surrounding the cutter. In other words, a high current density adjacent to the teeth is prevented. This construction eliminates the possibility of burning the edges of the cutter teeth. It has been found that for best results the ring should be about 1 in. larger in radius than the cutter.

One of the largest copper plating jobs is that of plating the tenon ends of rivet studs of many different sizes and shapes. These tenons are plated so that they will come out of the carburizing furnaces in a soft condition for riveting over. Special plating trays have been developed so that the copper is deposited only on the tenon portion of the rivet or stud. In general, these fixtures consist of a shallow pan with a number of holes in the bottom. These holes are counterbored from the inside of the tray to receive the stud body. Clearance around the tenon allows the plating solution to deposit the required thickness of copper, usually about 0.0008 to 0.001 in. As a matter of fact there is sufficient clearance to allow the fixture to be loaded several times before the copper deposit must be stripped off.

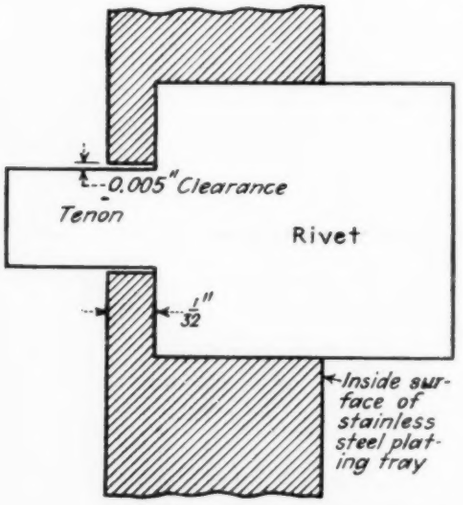
The tenon plating tray is loaded in the following manner. The tenons are inserted from the inside of the pan. When all of the holes are filled the space inside the box is packed with bronze chips to prevent the stud bodies from being plated. Then the cover is placed over the fastening studs and the hand knobs are tightened down.

TESTING TENON PLATING

After the loaded tray has been plated, the rivets at the center of the tray are tested for thickness of plate. The test consists of putting a drop of acid (50 per cent nitric acid—50 per cent distilled water solution 1:1) on each of several tenons and counting the number of seconds required to eat through the deposit. If after 45 sec. the acid has not eaten through the tenons are washed, wiped dry and a fresh drop of acid is applied. The total number of seconds are carefully counted until the brown nitrate of iron shows through the green copper nitrate. The total number of seconds is divided by nine in order to obtain the thickness of copper plate in ten thousandths of an inch. That is, with this strength of solution 9 sec. are required to dissolve 0.0001 in. of copper. The washing after 45 sec. is required because the acid is exhausted in that time. This method of test or some modification of the same is generally used and known in the plating industry.

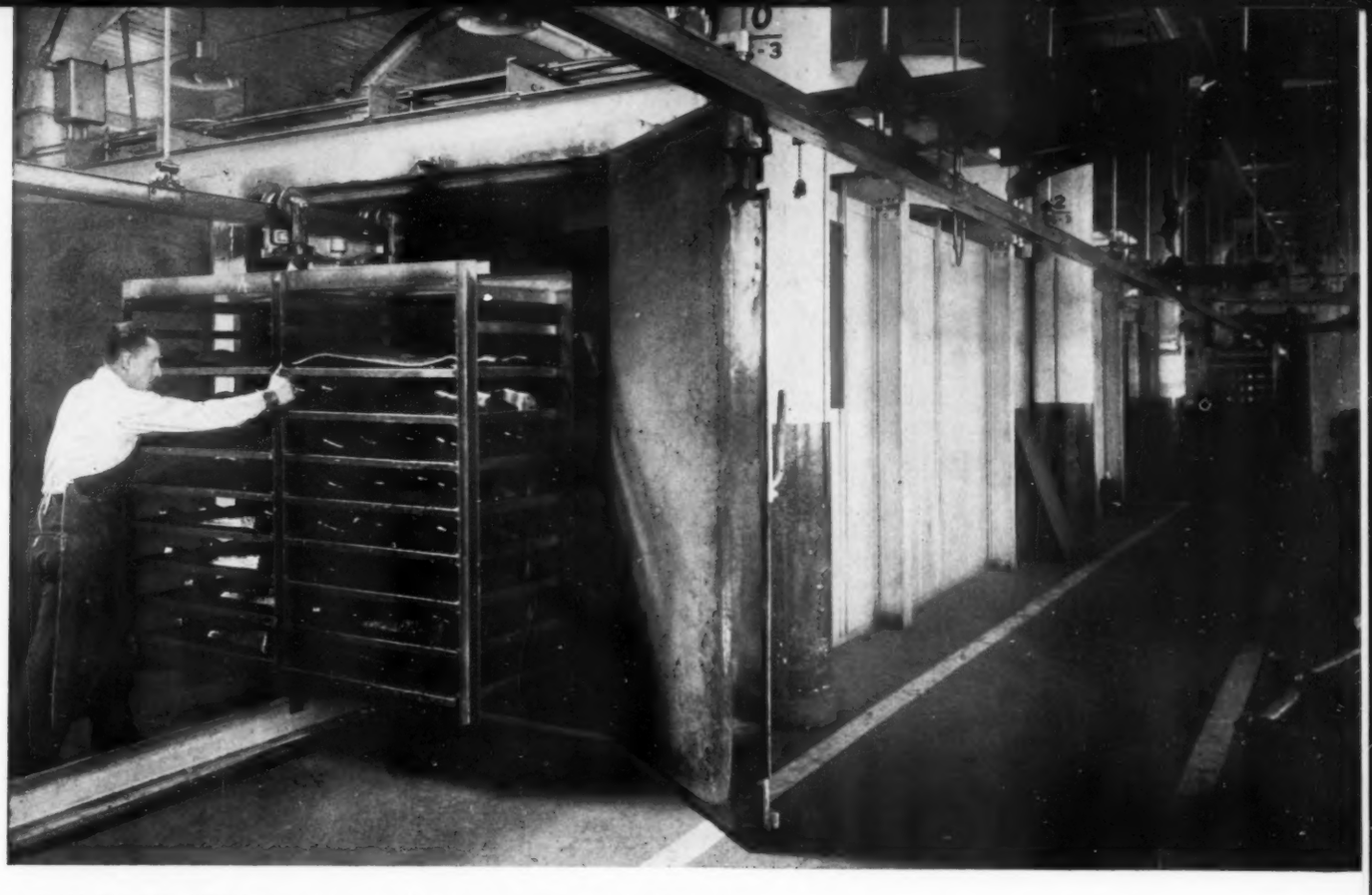
All rivet-tenon plating trays are made of stainless steel for two reasons. These are: first, the cost of manufacture is such that a material not attacked by acid is desirable; second, copper plate does not bond to stainless steel and can be stripped off easily. Acid stripping would require an enormous quantity of acid for the number of fixtures in use.

Heat-treated work from which copper is to be stripped is placed in a chromic-acid solution. This is composed of 4 lb. of chromic acid and 7½ oz. of sulphuric acid, per gallon. Its advantages over deplating with sodium cyanide are as follows: no current is needed, there are no fumes. When new, the solution will strip 0.001 in. of copper plating in 20 min., and it will not attack steel. Once made up the bath is kept in use without replenishment until it refuses to react further. Ordinarily this requires about one month of operation.

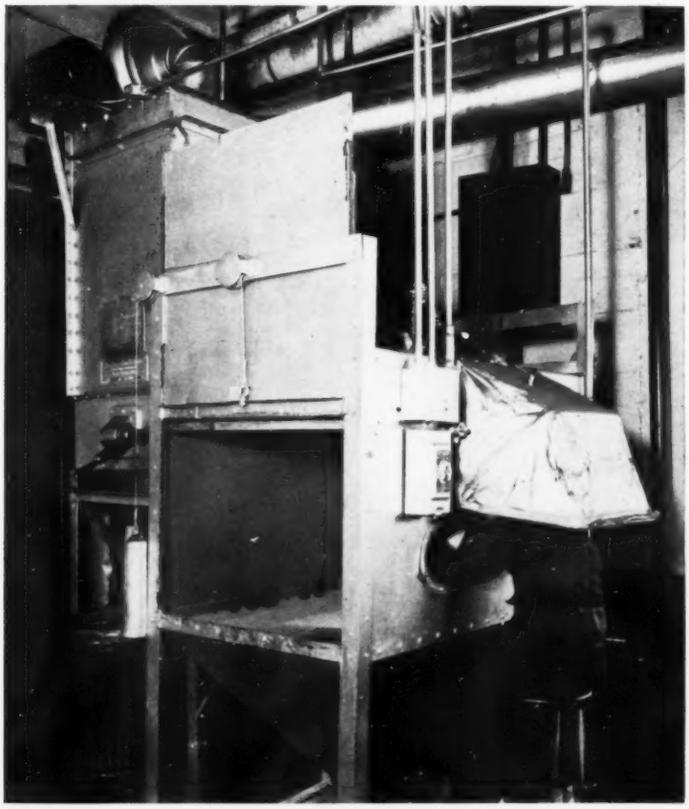


HOLES *for the rivet tenons are counterbored from the inside of the tray. The clearance specified will allow plating several batches before the holes plug up*

COPPER PLATING *is easily peeled off a stainless-steel tray. This is the bottom of a tray used for plating rivet tenons of small size*



THESE BAKING OVENS *are equipped with electrical interlocks so that the inlet-air fans shut down if the exhaust fans fail, thereby preventing explosions or forcing of vapors into the room*



PROTECTION *for shot-blast operators is secured through a hood and an air-filtering system*

A LINE ON FINISHING

At least $50,000 a year is being saved through recent conveyorizing of the finishing department and the adoption of a different covering material

ONE of the few places where straight-line production prevails in the I. B. M. plant is the finishing department. Work enters one end of the floor and travels through degreasing, shot blasting, spray painting, baking, cooling, striping and inspection and out the far door to stock. Another unusual thing about this department is that it is completely conveyorized.

This finishing department is one of the most modern in the country. It was set-up in its present form three years ago, and with the large Blakeslee degreaser now being installed, will lack nothing so far as equipment

now on the market is concerned. Considerable savings have resulted from the modernization of this department, but it is rather hard to state an exact amount. At the time new equipment was installed a new process of finishing was also adopted. Present practice involves the use of a crackle finish as opposed to an enamel for most of the work.

The decision to use a crackle finish was made after an investigation of the relative cost of this material as against the smooth enamel. On certain machines adoption of the morocco crackle finish permitted a saving of 74 per cent because the special care in smoothing the castings and the application of undercoats and the rubbing-down operation as formerly required for enamel finish were eliminated. When the management decided to make the change it also saw the value of changing methods and following the procedure to be described.

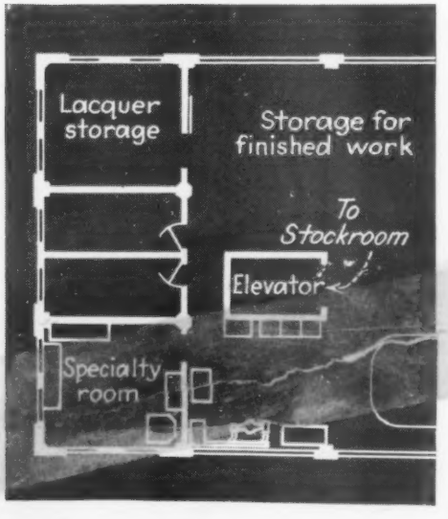
Work is handled in the finishing department regardless of size and composition. It may be a die-casting, an iron casting, or a sheet metal part of large or small size. First, the parts are degreased in a large Blakeslee machine and the iron castings are then shot-blasted in a large Pangborn outfit. The Pangborn machine is served by an individual monorail from the degreaser.

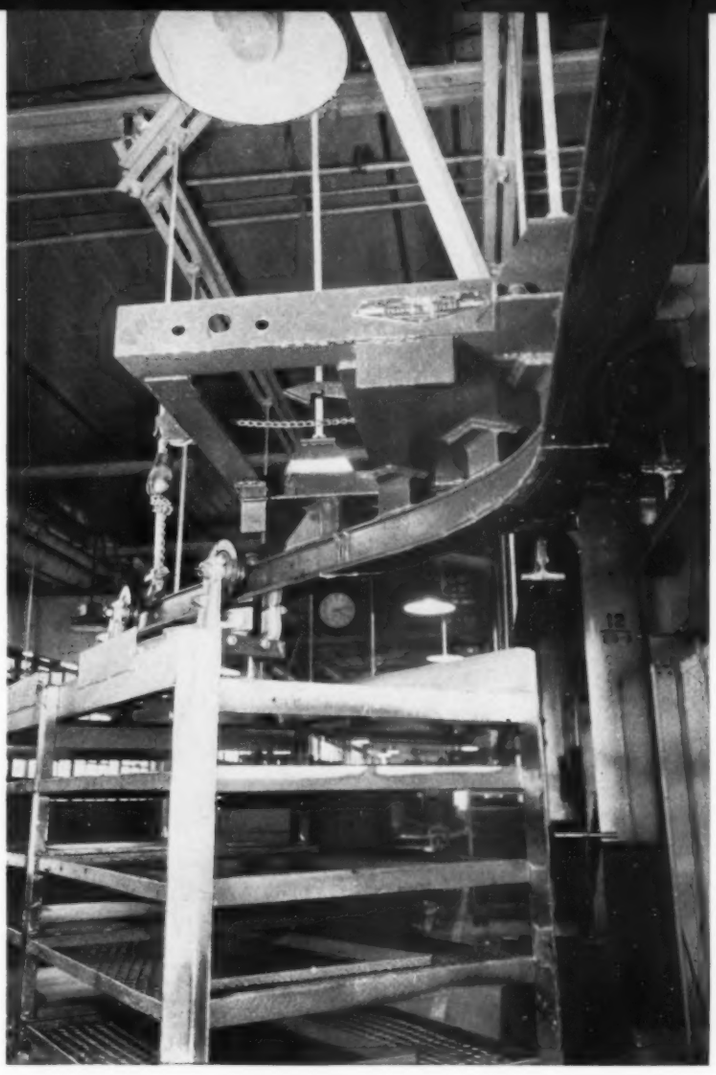
Sheet-metal parts on the other hand, after being degreased, are immediately racked and placed on the conveyor serving the spray booths and the ovens. Jobs are loaded in the order in which they must be finished. There is not much storage space around the Blakeslee machine, therefore the cleaned work is immediately moved in an orderly fashion along the spray line.

Besides the large Pangborn shot blast there is another one on the opposite side of the department used

MODERN DEGREASING *by the vapor-spray-vapor method is done in this Blakeslee degreaser just installed*

MACHINE BASES *are shot-blasted while mounted on a skid platform that gives proper support to the piece and facilitates handling through subsequent operations*





MANUAL TRANSFER SWITCHES *are liberally distributed throughout the conveyor system to shunt racks from one monorail to another*

for smaller parts and particularly for cleaning the burrs from drilled and slotted laminated and molded plastic parts. The spent shot from the larger equipment is employed in the smaller shot blast, because it has by this time been so reduced in size that it will not batter the plastic parts. About 3,000 to 5,000 plastic and metal parts are put through in a day.

Operators in the shot blasts work on the double shift principle—four hours on and four hours on other work. This system prevails for six months when the man is transferred to other departmental work for two years at least.

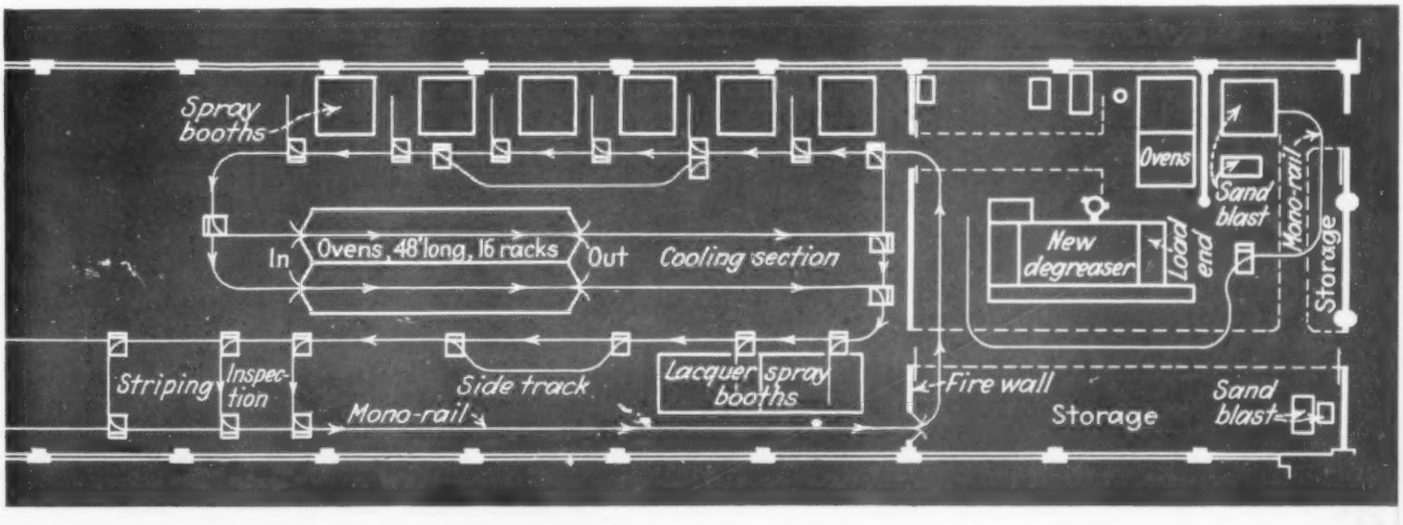
The entire shot blast installation does more than meet the state requirements for safety and health of employees. In fact the operator is constantly protected by a hood through which a supply of filtered and conditioned air circulates so that under no condition dust-laden air is breathed.

Each order is put on traveling racks suspended from a monorail. They pass down the outer wall and are shunted into the individual spray booths as fast as the operator can pick them off, as previously explained. Each spray boot is fire proof, has its own ventilation and lighting system. Crackle finish is sprayed on the work from a 30-gal. pot at one end of the line. Enamel finish is sprayed from individual pots in the booths.

After spraying the rack is run back on the main monorail and proceeds along the spray-booth line until it doubles back to the baking oven. The spray operator opens the door, pushes the rack in and his responsibility is ended. The rack is conveyed through the oven by means of a motor-driven conveyor within. Because of the mixed nature of the work it is necessary to compromise on the time in the oven. Through experience 2½ hr. has been established as the best operating period. Temperature in the oven is 300 F.

When a rack in the oven is ready for discharge an air-driven unloader advances to the opening doors of the oven. While advancing the unloader

METAL-FINISHING OPERATIONS *commence with degreasing in a vapor-spray-vapor machine at the right. Cleaned or sandblasted work then goes on the monorail circuit. As the arrows show, the work on racks progresses through spray painting with crackle finish, drying, cooling, clear lacquering, inspection and striping*



pushes the cooling racks ahead one position in the cooling section. With continued movement the unloader drops two pawls over the rack and pulls it out of the oven. The doors then close automatically.

RUSH ORDER HANDLING

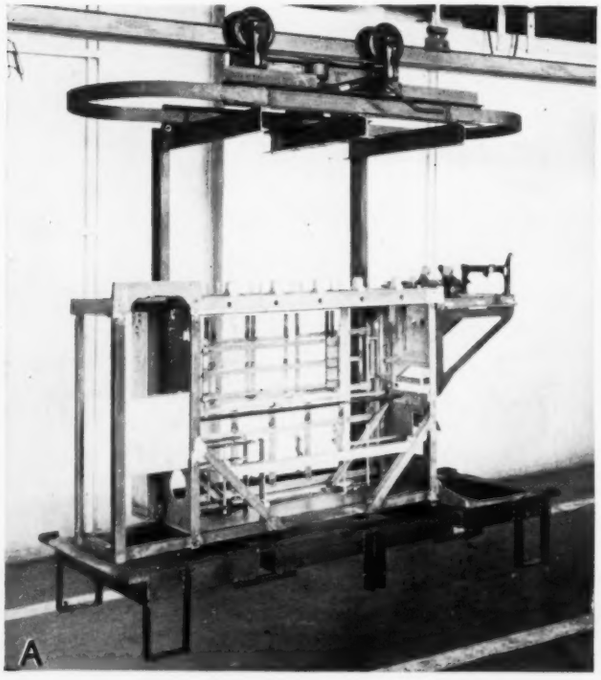
When the baked work has cooled sufficiently, it is pulled manually to the clear-lacquer spray booths. Almost 95 per cent of the work is given this additional finish. It is interesting to note from the floor plan that there is a side track just below the clear-lacquer booths. Suppose that a sudden hurry-up order is issued for a certain rack of baked work. By shoving the racks around, using the side track, it is possible to pull out one for immediate handling and to give the load a clear path to the inspection desks.

After inspection of painted surfaces, the baked work proceeds to the striping line. Striping is done by hand. At the striping station decalcomania transfers are applied for names and style numbers. Gold or silver striping is put on and the places where the application is made are sprayed again with a small lacquer hand gun. The work is then stocked for transfer to the stockroom.

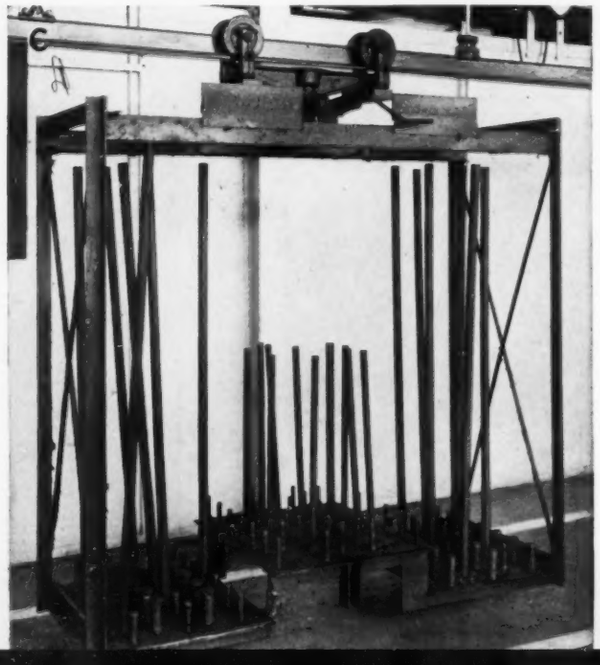
There is a specialty finishing department at one end of the floor as shown on the floor plan. Here special lacquer finishes, oxidized finishes and custom jobs are turned out.

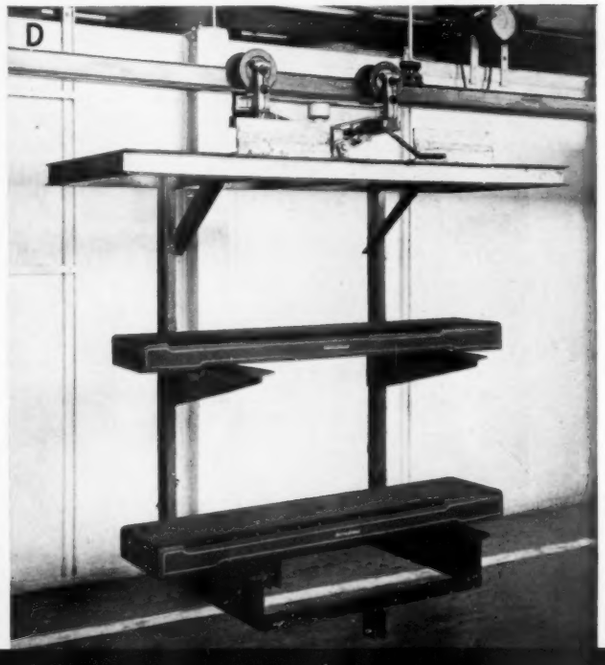
FOUR AIR CHANGES PER HOUR

The entire department is air conditioned involving a change of 30,000 cu. ft. of air per min., thereby accomplishing a complete change of air every 15 min. All motors and switches throughout the department are of the explosion-proof type.



RACKS OF FOUR TYPES *carry the work along the monorail system. Rack A takes a skid platform with a machine base mounted thereon, rack B has guides for wire-screen trays, rack C has upright studs for pipes, and rack D is an open C-shape to carry large pieces*





PARTS PLACED *within easy reach and well designed work blocks facilitate the operator's motions in electric relay assembly*

PARTS TO MACHINES

A breakdown into logical steps permits specialized handling of a complex assembly sequence

ASSEMBLY begins at I.B.M. wherever two parts are joined together. Approximately a third of the personnel of the I.B.M.'s Endicott plant is employed on assembly operations.

In the sub-assembly department on an average 275 various assembly operations are completed daily. In

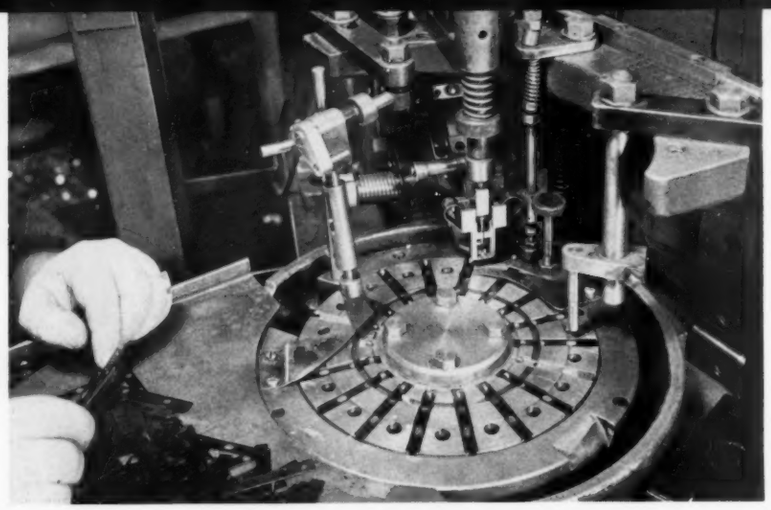
1936 more than 33,000,000 parts were used in the production of 235,000 relays of various types. Progressive assembly is used, with mechanisms passing through the department in an orderly routine and each employee specializing on certain operations. These mechanisms include cams, ratchets, type bars, type wheels, contact brushes, contact points, side and base plates, gears and relays.

Mechanical equipment is available for such operations as welding, brazing, automatic spinning and taping. In addition this department contains light punch presses, automatic hammers, riveting machines, and drill presses for reaming and taper pinning.

One of the typical assembly jobs is that of the multi-contact transfer relay which contains some 300 component parts. These relays are assembled by girls who pick the parts from a semi-circular series of containers. Ratchet screw drivers and socket wrenches help speed the work of putting the parts together. At the benches used for this work, two rows of girls sit opposite each other and place the finished work on a raised conveyor platform along which it is passed to the next operation.

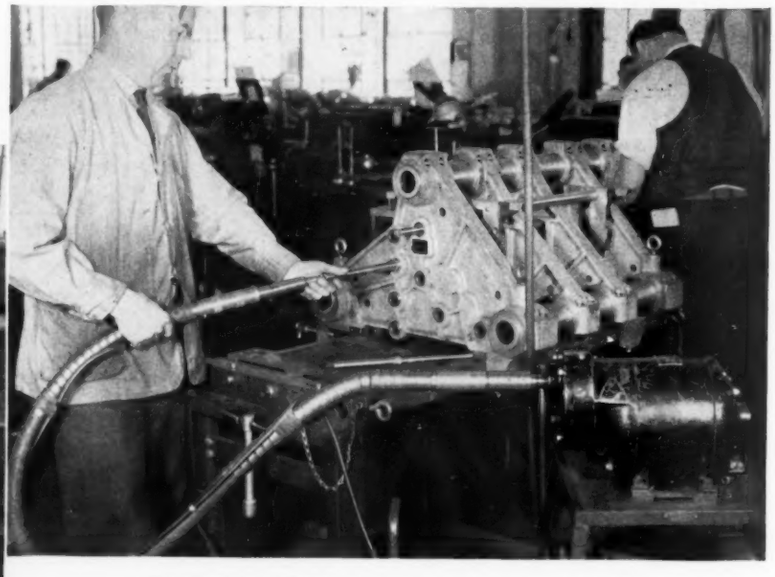
Brushes for I.B.M. machines consist of a series of fine wires bound together at one end by a sheet-metal band. This wire is assembled in long lengths in sheet metal ferrules. The resulting strips are crimped and cut off in a single machine. The short sections are then placed in a fixture and the ends of the wire ground to the proper angle.

The unit assembly department works on all major units for tabulating equipment. Such units consist of various kinds of counters, printing units, paper carriages, type bars, control units and magnet units. They



SILVER CONTACT POINTS *are rolled in at the rate of 1200 an hour by the use of a special machine*

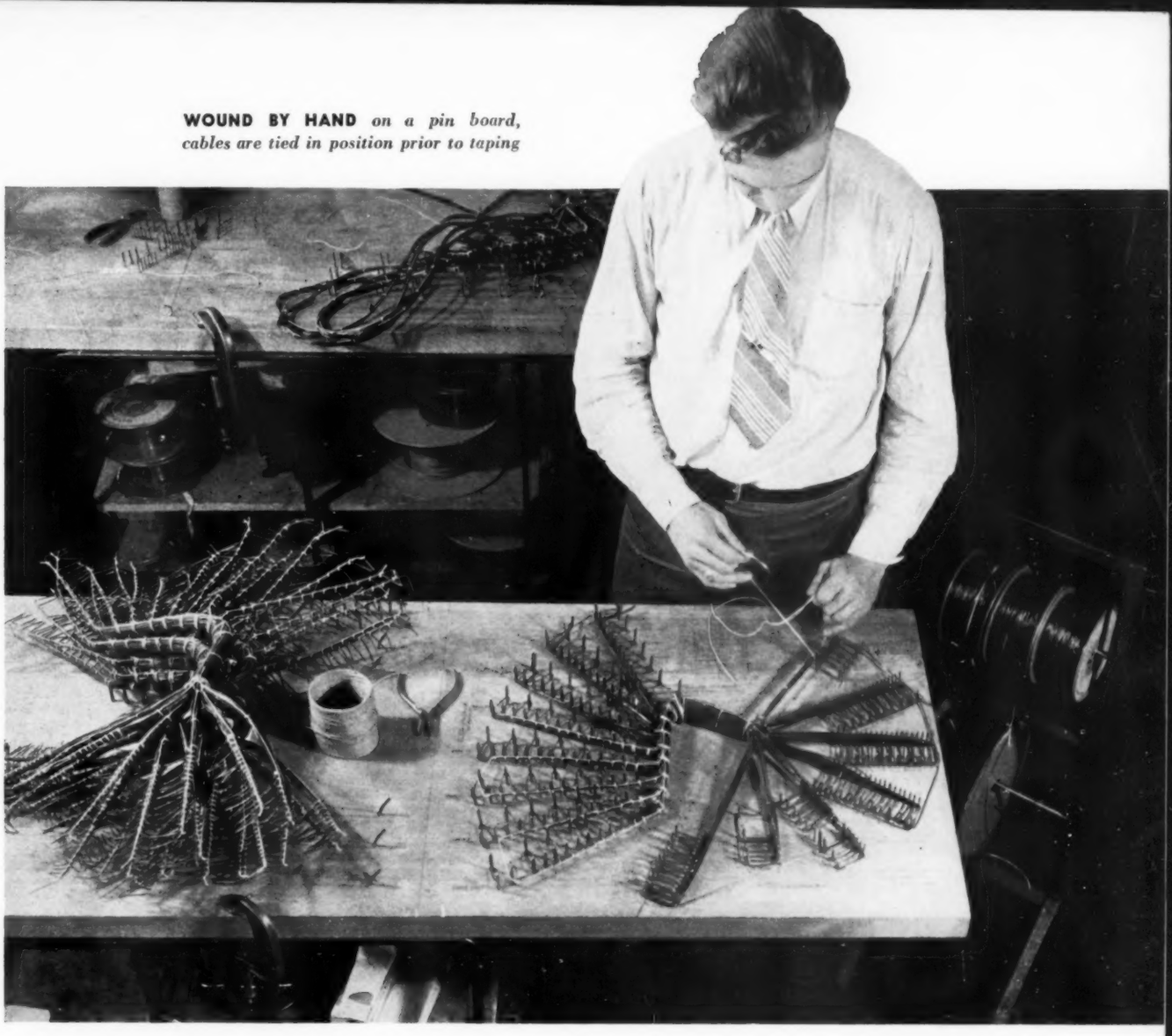
DETENTS AND STUDS *are assembled and riveted at the rate of 250 an hour using a high-speed hammer*



BEARING HOLES *in the base are line reamed with portable equipment before the shafts are fitted*

UNITS ARE PUT *on the control panel as one of the steps in the International Time Recorder assembly*

WOUND BY HAND *on a pin board, cables are tied in position prior to taping*



are assembled, inspected and tested both for mechanical and electrical operation and, when they are completed, sent directly to the final assembly department. In work of this kind there is, of course, a great deal of hand bench assembly of all kinds, including operations such as soldering. Small special fixtures are used to insure correctness.

In the base assembly department, the base, feed and drive mechanism for all numerical tabulators and multiplying punches are assembled. After inspection, they are moved to the wiring section of the final assembly department where all electrical wiring, relays and electrical control devices are installed. Bill feeding devices, alphabetic accounting machine card feeds and various other cam and gear assemblies are completed here.

In the cable and plug-board assembly, 525 different kinds of cables are wound, containing from a few feet to over 6,000 ft. of wire, depending upon the number of electrical circuits and the machines in which they are used. An average of 80,000 ft. of wire are used daily. To the ends that are used for electrical connections more than 15,000 terminal clips are attached.

ONE MILE IN 11 HOURS

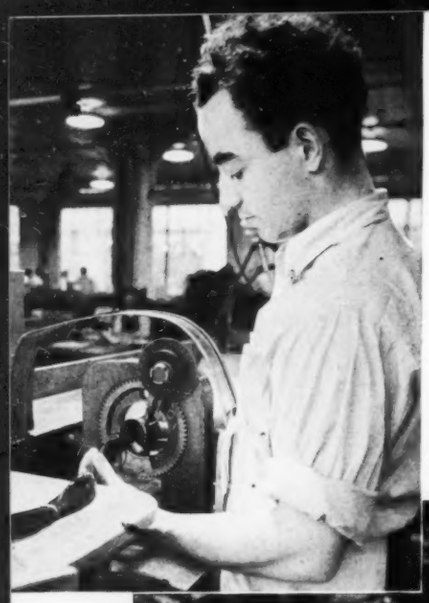
In making up cables for the alphabetic tabulating machines and similar equipment, the operator passes the wire over a series of pegs back and forth following a blueprint layout. After about three months' training, an operator can follow the sequence of pegs from memory. A cable containing approximately one mile of wire is wound in about eleven hours. These cables are roughly tied together before being removed from the board and are then taped by a machine.

An excellent example of a compact unit is the plugboard. A board, 11 by 19 in., has more than 1,500 electrical circuits terminating in it. This plugboard affords the means by which customers control the various operations of the electrical bookkeeping and accounting machines. About 14,000,000 parts are used annually in the assembly of these plugboards.

Approximately fifteen various types of punching equipment are assembled in progressive line assemblies. Sub-assemblies or this equipment are also completed and inspected in the department doing this work and are fed into the assembly lines at the proper points. This department is also the final assembly for gang punches, gang summary punches and reproducing punches.

Several types of card sorting and matching machines, together with numerical interpreters and check-writing machines, are assembled in another department set aside for this purpose.

Still another department handles the final assembly for five types of non-printing tabulators, four types of printing tabulators and two types



CABLES ARE TAPED *by machine using a simple home-made device*

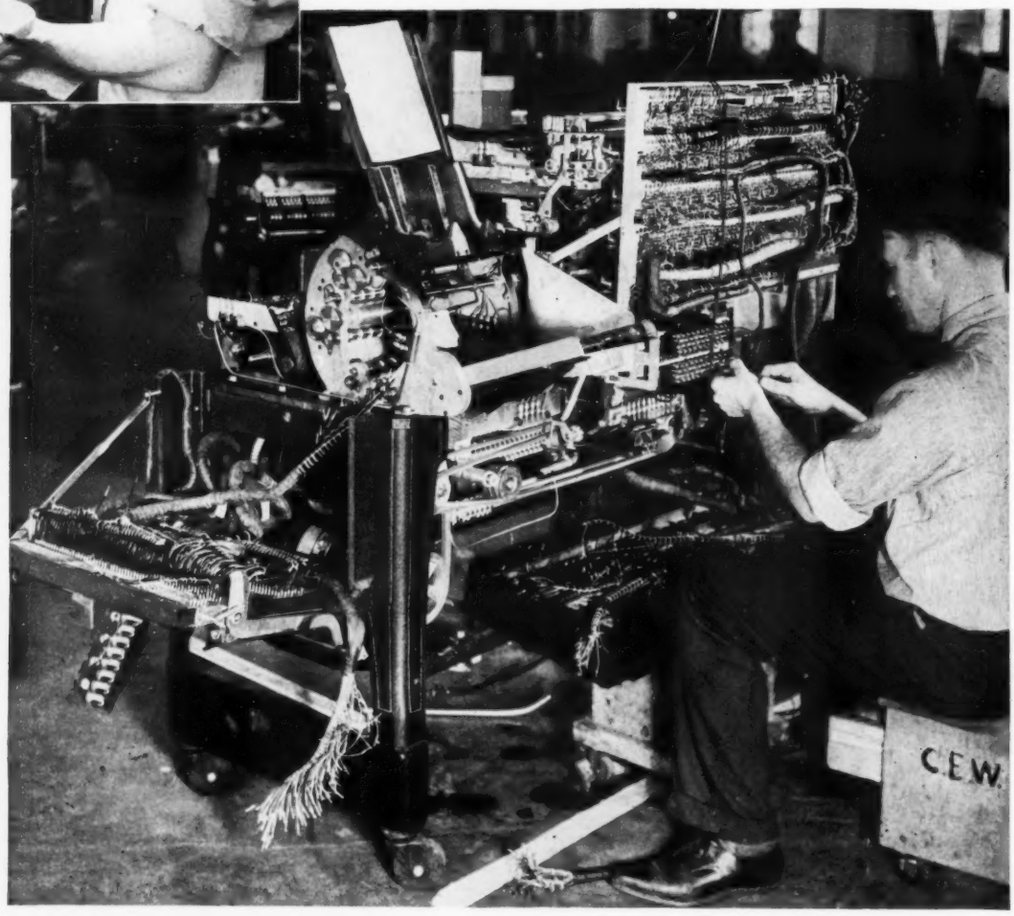
of printing and billing machines used by chain stores and public utility companies. This department also does the final assembly of the multiplying punch machine and the alphabetic interpreter.

In the assembly of alphabetic bookkeeping and accounting machines the base of frame of the machine is first mounted on a dolly of special design which allows the operator to turn the work over, as many parts and units are assembled on the top and bottom of the base. After the legs have been installed, the machine is mounted on a pair of wooden skids and progresses step by step as each assembler performs his assigned operation.

The time recording division handles the final assembly of such products as card time recorders, dial recorders, job time recorders, time stamps, ticket validating stamps, master control clocks, bell ringing devices, fire alarm equipment, time flash devices, indicating wall clocks, sound distribution equipment, traffic recorders, and athletic timers. These devices are assembled in two divisions, one for mechanical and one for electrical equipment.

In this department, sub-assemblies are built along with the unit assemblies with the arrangement of benches worked out so that the sub-assemblies will feed into the unit bench at the proper points in the operation. For the many special devices to be built it contains a small job shop complete with drill presses, milling machines and lathes. Type casting is also done in this department.

Because of the wide variety of products which this department turns out, many unusual problems arise. In cooperation with the Philco Radio Company, I.B.M. manufactures sound recording and amplifying equipment. One of the new developments in this field is known as the "School Master" whereby each classroom is wired directly to a master instrument in the principal's office. By means of this equipment, the principal may send to all or any group of classrooms his verbal comments, sounds from a recorded disk, or a radio broadcast from either a standard or a short-wave set. In addition, he can listen to recitations or lectures in any room he may select.



MILES OF WIRE *must be connected to hundreds of terminals before the electric circuits are completed*

The proof machine for banks is assembled in a department set aside for this purpose. This procedure follows that already described for other I.B.M. final assemblies.

After final assembly and inspection, workmen skilled in all types of machines carefully dismount such parts that might be damaged when shipped and pack each unit individually to insure its safe delivery to the customer. All working parts are checked to see that they are properly oiled and that sufficient grease has been applied. In the case of foreign shipments, care is exercised to protect parts against corrosion.

STOP AND GO

Holding and handling 45,000 different parts in various stages of completion is made easier through the use of I.B.M. tabulating machines and counting scales

HANDLING of raw and finished materials, parts in process, finished parts, and assembled machines is a function of the receiving and stores department, as is indicated by the inclusion of trucks in the statistics of the department. On the average, each of the 45,000 parts has to be handled five times. Some one of the figure chasers has calculated that the 148 men in the department handle 240,000,000 lb. per year.

Everything that enters the plant naturally passes through the receiving room to be inspected, recorded and sent to the proper place. All of it must be cleared within 24 hours of its arrival. Raw materials go to the raw stores department where they are designated by code numbers corresponding to the finished part numbers involved. Material is requisitioned to the machining room, and when finished moves to the finished stock department. From here it goes either to the field stock room or to subassembly stock rooms, each of which serves two adjacent assembly departments.

Parts assigned to the field stock room, where a three-months supply is carried, are used solely for maintenance and repair work in the field. Shipments are made to a given region on the same day each week, unless there is an emergency call for quicker delivery. All parts are reinspected before they are shipped.

All stock rooms are characterized by broad aisles and a locating sys-

ALL NECESSARY INFORMATION *is entered on this stock card. The tag is torn off and as much as is needed used to mark the bin location*

WIDE AISLES, *steel shelving and a carefully worked out system of locating each part by section, shelf and bin numbers characterize this main stock room and the various branch stock rooms*

tem designating section, shelf and bin that corresponds to the best of city, street and house number systems. A stock location card is illustrated. The tab is removed and attached to the bin, as much of it being used as necessary. For the edge of a shelf only the top section is attached, for a large bin the whole tab. The main portion of the card goes into the stock file until the part is obsoleted. The card is then turned upside down and filed in the obsolete stock file with the new location entered on what is now the top of the card.

STORES STATISTICS

Freight cars unloaded per month	100
Motor trucks unloaded per month	1 mile
Raw Material items unloaded per month	8,000
Raw Materials received per month	4,000,000 lbs.
Metal withdrawn from raw stores per year	3,500 tons
Wire withdrawn from raw stores per year	500,000 miles
Area of finished stock room	29,000 sq. ft.
Number of separate items	45,000
Requisitions filled per week	9,000
Electric trucks in use	5
Lift trucks in use	35
Number of employes	148

HAND LIFT TRUCKS *of several styles are used to move crated or boxed material*

ALL SORTS OF TRUCKS *find their way into and out of the receiving department*

ONE OF THE FIVE *electric trucks used for heavier parts and longer distances*

FILLING REQUISITIONS

On the average, 375 different items reach the stock room daily. Small parts are usually boxed in convenient lots in paper boxes before they arrive. Some 9,000 requisitions per week are filled here, the routine procedure being to proceed from section to section in sequence, with a standard stock handling cart in which to collect the various parts. These trucks, and 70 per cent of the bins, were supplied by Lyon Metal Products. In addition there are hundreds of special wooden tote boxes in which delicate parts are racked for protection while being handled. Red tickets are used to mark empty bins from which parts have been requisitioned. The department operates on two shifts.

In the assembly stock rooms stores are received charged to assembly. The parts are grouped by units and delivered by feeders to the assembly floor about an hour before they are needed.

Inventory of finished stock is taken twice a year, but is a continuous process. Three men put in full time on this job to check the card inventory making the full round of the stock bins every six months.

LOOKING FOR TROUBLE

One out of every ten men in the Endicott plant is an inspector who seeks out trouble before it starts and stops future trouble at its source

QUALITY CONTROL is considered so important by the I.B.M. management that this responsibility is given to an inspection department that is entirely independent of the supervision of the production department. The inspection department controls the quality of all purchased materials, machining processes, sub-assemblies and final assemblies through preparation for shipment of the completed machines.

The department has seven subdivisions as follows: purchased materials inspection, tool inspection, parts inspection, sub-assembly and unit inspection, International time recorder final inspection, tabulating machine final inspection (major machines), and tabulating machines final inspection (auxiliary machines and printing). These divisions all report to an inspection supervisor who is directly responsible to the management.

In the purchased materials division all materials entering the plant are passed upon and accepted if they are up to I.B.M. standards. The chief materials used are steel of all kinds, castings both ferrous and non-ferrous, die castings, bakelite moldings and sheets, sheet metal parts, glass, electric wire and rubber. These materials may be received in the raw state, as semi-finished parts or as completely finished parts.

The basis for material quality is the I.B.M. specification book which contains 11 major material classifications and 83 minor classifications. A sample specification sheet, reproduced here, shows I.B.M. requirements for free-machining stainless steels. Such specifications are prepared by the company's metallurgical department. Material is sampled and tested in the laboratory before it is accepted.

Parts are inspected by comparing them to their blueprints. Suppliers

INTERNATIONAL BUSINESS MACHINES CORP.
METALLURGICAL DEPARTMENT

This specification is issued for the use of employees of INTERNATIONAL BUSINESS MACHINES CORP. and authorized suppliers. Not for publication except on approval of the Metallurgical Department.

MATERIAL PURCHASE SPECIFICATION
No. S-1 **12-14-34**

FREE MACHINING STAINLESS STEEL — COLD DRAWN.

1. PURPOSE

This specification covers COLD DRAWN FREE MACHINING STAINLESS STEEL in rounds, hexagons, squares and flats for the manufacture of screw machine and other parts which require corrosion resistance and are not heat treated.

2. REQUIREMENTS

2.1 GENERAL

The bars shall be free cutting and suitable for screw machine work, leaving a smooth finish after machining. The bars shall have a smooth surface and shall be free from injurious defects such as cracks, laps, seams, pipes and coarsely crystalline structure.

2.2 COMPOSITION

Carbon	Manganese	Sulphur	Phosphorus
.12 max.	.15/.50	.25/.50	.045 max.

Silicon	Chromium
.20/.50	12.0/15.0

2.3 TEMPER

The bars shall have a Rockwell B hardness of 95-105, or equivalent Brinell hardness of 228-255.

2.4 DIMENSIONS

The variations in dimensions shall not exceed the limits given in the following tables. The length shall be 8 to 12 ft.

Rounds and Hexagons

Diameter	Tolerance
up to ¼"	±.001"
¼ to 2-¾"	±.002"

Flats and Squares

Diameter	Tolerance in Thickness	Diameter	Tolerance in Width
⅛" to ¼"	±.001"	¼" to 1"	±.002"
9/32" to 1"	±.002"	1-1/32" to 2"	±.003"
1-1/32" to 2"	±.003"	2-1/32" to 3-½"	±.004"

3. TESTS

The INTERNATIONAL BUSINESS MACHINES CORP. reserves the privilege to check dimensions, inspect finish and make chemical and physical tests, including machining tests on any portion or all of a shipment.

4. PACKING AND MARKING

Material shall be packed in such manner that it will be protected from injury in handling or in transit. All shipments shall be properly marked and separated by grade and size.

5. REJECTION

5.1

Material not complying with all the requirements of this Specification shall be subject to rejection and vendor shall be notified.

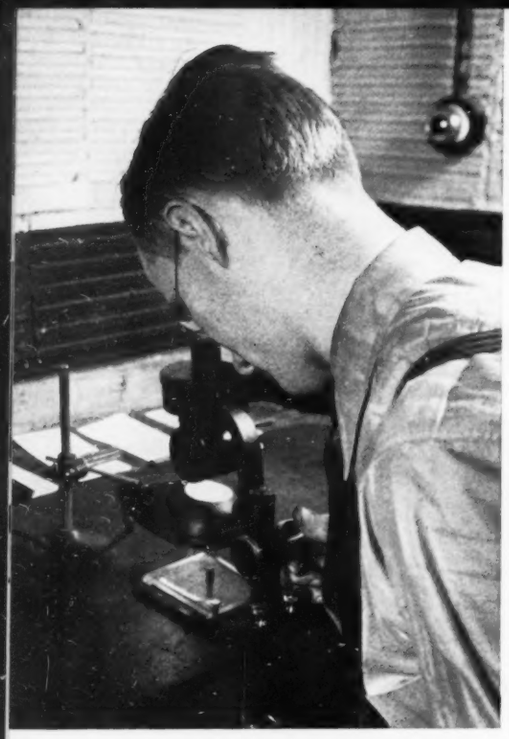
5.2

Material in which injurious defects are revealed by manufacturing operations subsequent to acceptance shall be subject to rejection and vendor shall be notified.

5.3

INTERNATIONAL BUSINESS MACHINES CORP. reserves the right to reject any part or all of a shipment, irrespective of whether part or all of the shipment is defective.

INTERNATIONAL BUSINESS MACHINES CORP.
METALLURGICAL DEPARTMENT



A BINOCULAR MICROMETER *is used to determine depth of case as part of the process control in the heat-treating department*

CONTOUR PROJECTORS *afford a quick and accurate means of inspecting irregularly shaped parts*

INSPECTION DETAIL SHOP COPY

PART NO.	OPERATION	NAME		
141000	36	Carriage Frame		
DATE	FILE NO.	DRAWING NO.	TYPE MACHINE	
4/15/37	40	D	U. & A. Plr.	Auto Paper Carriage

SPECIFICATIONS

1 - CHECK FOR ALL OPERATIONS UP TO #35 BEING COMPLETED.
2 - INSPECT 100% TO B. P. SPECIFICATIONS ONE PIECE AND CHECK 100% BY COMPARISON FOR CONTOUR AND FORM.
3 - INSPECT 100% FOR SLOTS BEING PARALLEL AND STRAIGHT.
4 - INSPECT 25% .125 +.000 - .001, .187 + .000 - .005 DIMENSIONS.
5 - INSPECT 10% WITH 10-32 AND 5/16-18 THD. PLUG GAGES.
6 - INSPECT 10% LOCATION OF TAPPED HOLES AND SLOTS.
7 - INSPECT 10% 15.250 + .000 - .005 DIM
8 - INSPECT 100% DIMS. NOT WITHIN B. P. LIMITS.
9 - INSPECT 100% VISUALLY FOR FINISH AND BURR.

USED ON ASSEM. #142002.

AN INSPECTION DETAIL *card serves to tell what dimensions need checking and what percentage of each lot must be measured*

are notified to submit samples of parts made on an initial order before proceeding with shipment of the entire lot. Approval of the sample authorizes tooling charges for that part and constitutes a release of the shipment.

STEEL AND SPRINGS

Approximately a third of a million dollars worth of material is received and inspected each month. The general procedure on materials, such as steel, is to check the color coding which identifies the steel, test for hardness, check dimensions and straightness, and inspect the finish. Springs are tested either in compression or tension as the case may be on a Coates spring testing machine at the working stress. The size of wire, number of coils and shape of loops are also investigated.

I.B.M. has done considerable research on electrical and magnet wire because the products of the company have elaborate wiring arrangements. Special wire has been developed to get high insulating quantities in a small diameter and at the same time to withstand the extreme ranges of climate, as these products are used in every principal country in the world.

I.B.M. works on a proven theory that it is more profitable to have a well organized and efficient process inspection to detect errors before scrap or improper assembly results, than a large parts inspection department who at best can only detect and eliminate defective work. Process inspection checks the first piece of any manufacturing set-up, whether it be machine tool, riveter, or mechanical assembly operation; and only when everything is correct is the operation permitted to begin. This is accomplished by a tie-up between the process inspector and departmental clerk. In addition, a process inspector is assigned to a given number of machines, and he periodically checks each operation. The number of machines which may be assigned to one process inspector varies from ten to twenty, depending upon the kind of operation.

As an example of thoroughness of this process inspection, it may be pointed out that it extends to the heat-treating department where the process inspectors are men trained in all phases of heat-treatment and are familiar with temperatures, time, and methods required. Case hard-

ening depth is checked by means of test pieces cut from stock of the same material as parts being heat-treated, inserted with the machined parts and tested to destruction. This gives an accurate check at the cost of only raw material.

Parts of a simpler nature such as screw machine and punch press parts, which are completely finished at a single operation, may be moved directly to stock at the discretion of the process inspector where his experience on periodical checks indicate that later inspection is unwarranted. To aid this, parts produced between his checks are kept separate and placed with the finished work by the process inspector.

These are a few of the details of this department that, in addition to the stressing of quality throughout I.B.M., result in a scrap loss of less than one per cent on a quantity basis.

CENTRAL PARTS INSPECTION

With the exception of those mentioned as going directly into stock, all parts are sent to a centralized parts inspection department for final check against the blueprint. The inspector is guided in his work by an inspection detail card which contains the accumulated experience as to what may possibly go wrong with the operation. This card tells him what dimensions to gage and the percentage of inspection necessary on the various dimensions. Unusual circumstances or operations are noted on these cards.

Since I.B.M. machines use many latching devices and other parts with irregular contours, many Jones & Lamson contour projectors are used both for process and parts inspection. The use of contour projectors reduces gaging cost since a staging block for the projector may cost $15 whereas a special gage for the same part might cost $100. In addition, handling time is decreased.

However, all parts do not lend themselves to contour projection, and in such cases, they are frequently inspected by built-up fixtures employing dial indicators. Since parts in the I.B.M. plant are usually run on a three months production basis, a great many dial indicators would be tied up if they were left with the fixtures at all times. To prevent this tying up of dial indicators and the idle investment, they are removed from the fixtures when not in use. This interchange of indicators is aided by a special I.B.M. back, which lends itself to quick assembly and adjustment. It consists of a simple pin which is locked in place by a set screw instead of the standard yoke type indicator back.

Indicators are marked for maximum and minimum tolerances and are kept filed in the inspection crib according to these tolerances. Selected indicators are assembled to the fixtures and adjusted to a master in the gage crib when the job is to be run.

GAGE CRIB HANDY

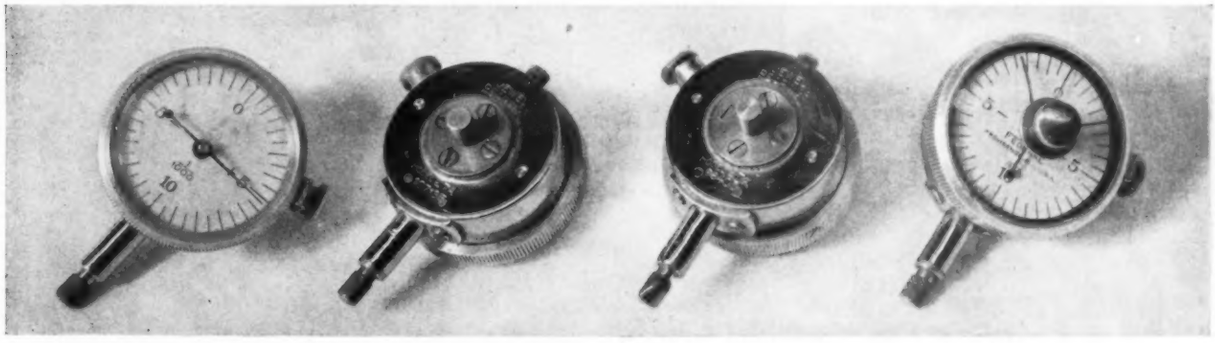
The gage crib is located in the machining department and is the control center for all measuring devices used in the plant. In this crib is kept a laboratory set of measuring blocks which is periodically certified by the Bureau of Standards. This set furnishes the standard for the Endicott plant and is used only in the inspection of working blocks. To check the working blocks with the master set a Pratt & Whitney Electrolimit gage, accurate to five millionths of an inch, is employed.

SIZE BLOCK PROGRESSION

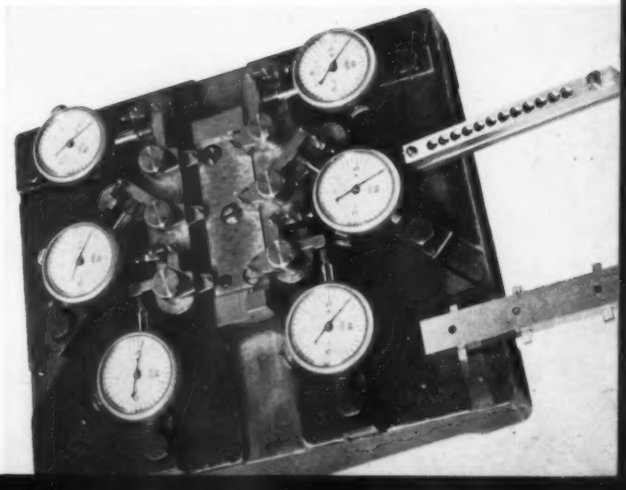
There are four classes of working gage blocks used respectively for tool inspection, the toolroom, the machining department, and the assembly department. On these blocks a successively wider tolerance range is allowed, according to departments in the order mentioned. For instance, after a block has worn beyond the limit specified for tool inspection, it may be moved to the toolroom. A greater variation will cause it to be sent to the machining department, and further wear will find it in the assembling department. The blocks are not moved as a set but as individual blocks, based on the amount of wear.

Gages assigned to various departments are periodically inspected in the gage crib. Here men are employed who have been trained to make minor repairs to measuring equipment such as micrometers, height gages and dial indicators. Stocks of repair parts are kept on hand for this purpose. Chromium plating is used to prevent wear and to reclaim plug gages, snap gages, etc.

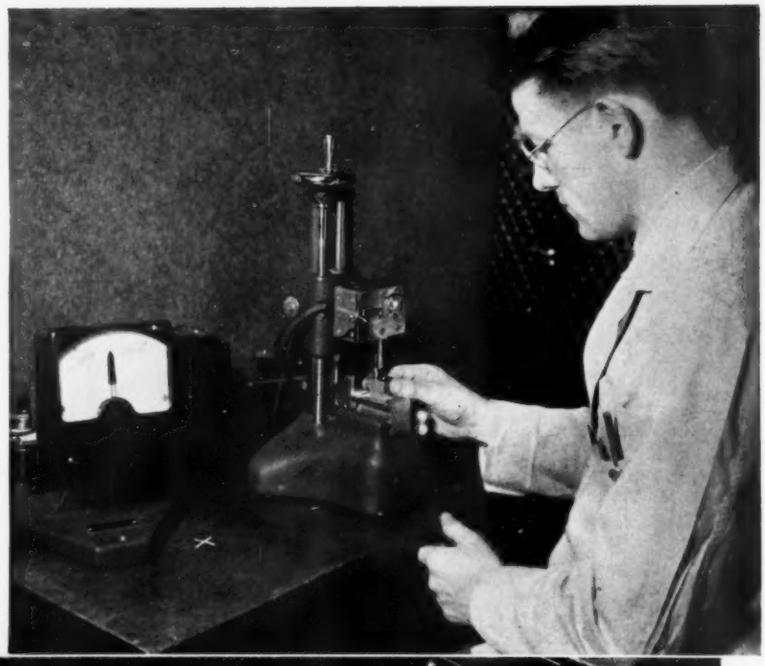
Since the tool inspection department has been described in the sec-



THE SPECIAL I. B. M. BACK *gives ease in mounting so dials may be removed from fixtures not in use*



DIAL INDICATORS *mounted in adjustable fixtures serve to check dimensions on much of the work*



WORKING GAGE BLOCKS *are checked in an Electrolimit gage and classified as to tolerance limits*

tion under tooling, it will not be discussed here again.

The inspection division having charge of sub-assembly and unit inspection checks all processes from the time two parts are joined together up to large units of 500 or 600 parts ready for final assembly. The inspections include both mechanical and electrical assemblies.

Gaging fixtures for unit inspection often duplicate the mounting of the final machine which insures that the units are interchangeable. These precautions eliminate delay in assembly.

All adding units for tabulating machines are tested for correct operation and are run above and below their operating speeds as well as at normal speed. This range insures a margin of safety in the use of these units.

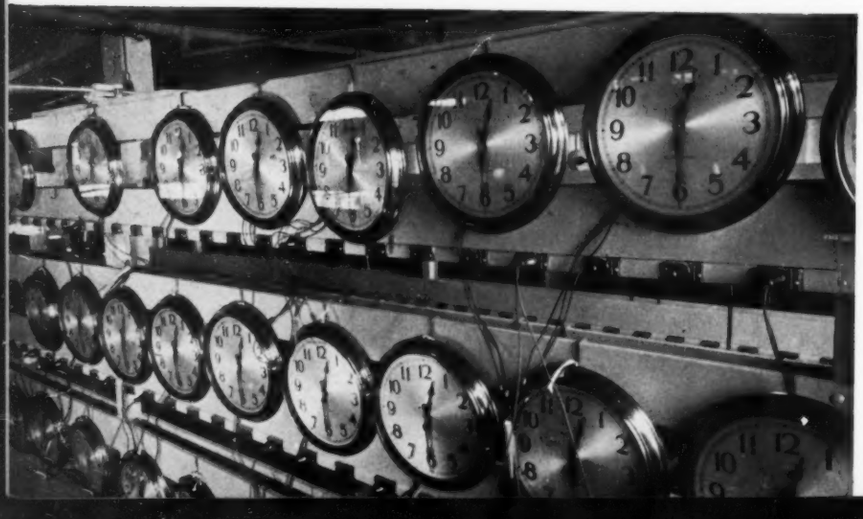
SPLITTING SECONDS

Electrical units are tested for high voltage breakdown to ground. The units which have definite speed requirements are checked for pick-up time and drop out time on special devices developed by I.B.M. One such device uses the stroboscopic principle to detect the bouncing of relay contact points to 1/10,000 of a second.

The men who look after final assembly inspection have all had field experience with I.B.M. A detail card is used to guide the inspector in all final assembly inspections.

Inspectors in the International Time Recording Division are responsible for the completeness, appearance and accuracy of all finished time-recording units. These units are placed on large test racks and checked under actual operating conditions. The racks have a capacity for testing up to 500 units simultaneously and are arranged to be supplied with a great variety of electrical current, both a.c. and d.c. to fit the particular specifications of the apparatus. For unusual pieces of equipment, special testing robots are frequently constructed. For example, in order to inspect a traffic recorder recently developed by I.B.M., a robot has been built to give the effect of cars passing a given point, bumper, to bumper, at 60 miles an hour. This, of course, is an extreme condition, but all units must pass this test.

A SMALL NEON BULB *on the periphery of a revolving disk shows pick-up and breaking time of relays to a ten thousandth of a second*

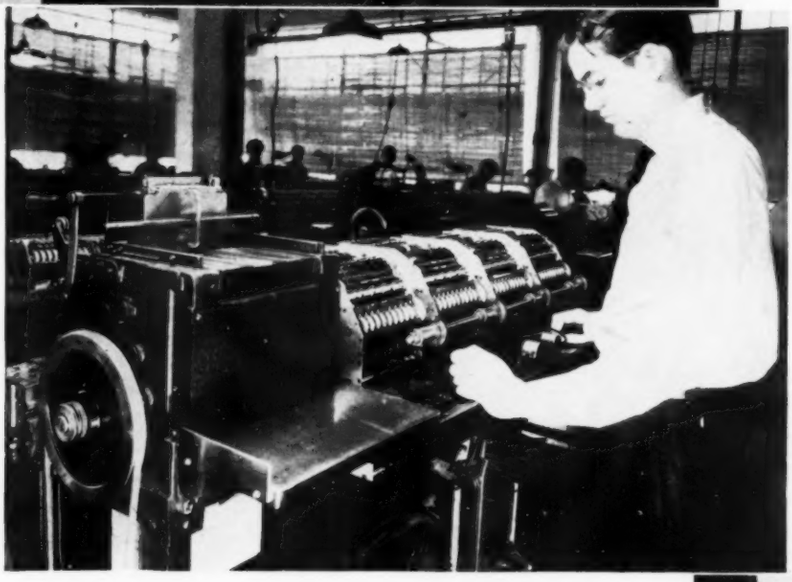


THERE'S NO DOUBT *that it's 12:30 when 500 time recorders on the test rack agree to the minute*

International master clocks are guaranteed to an accuracy of two seconds per month. Consequently each unit must be closely checked and regulated.

In the final inspection of account-

PROCESS INSPECTION *of relay sub-assemblies is handled progressively with special emphasis on good lighting*



ing machines, the assembly is checked by the process method at frequent stages. For example, after the cabinet and major drive is assembled to the base, the machine passes through an initial assembly inspection. Another inspection is made and assembled with all electrical de- after the machine is completely wired vices. This inspection includes the timing of these devices, cam operation, neatness and conformity with customer's specifications. The machine is then further assembled to the point where all adding operations can be performed, and progress is again inspected up to his point. Still another inspection is made after the machine has been completed in order to determine the correctness of the assembly. The machine is then covered and placed in condition of actual operation in the customer's office. After this it goes into the final test department where it is used on all operations it will be required to perform, running actual reports which are checked by two individuals for possible error. During these tests the machine is run at capacity and at speeds below and above standard.

RECORDS IMPROVE PRODUCT

Permanent records of all machine performance are retained and checked with performance after installation. This practice makes available a complete set of records of the entire history of the equipment through the assembly processes. By comparing such information with performance data in the field great strides have been made in improving performance of the product.

In the card department, cards are inspected for correct size and printing. Where pre-punching is done, this is also checked. All the precautions taken by the Bureau of Engraving & Printing at Washington are followed to control the actual number of cards used as bank checks and to make sure that no surplus will ever get into an unauthorized channel.

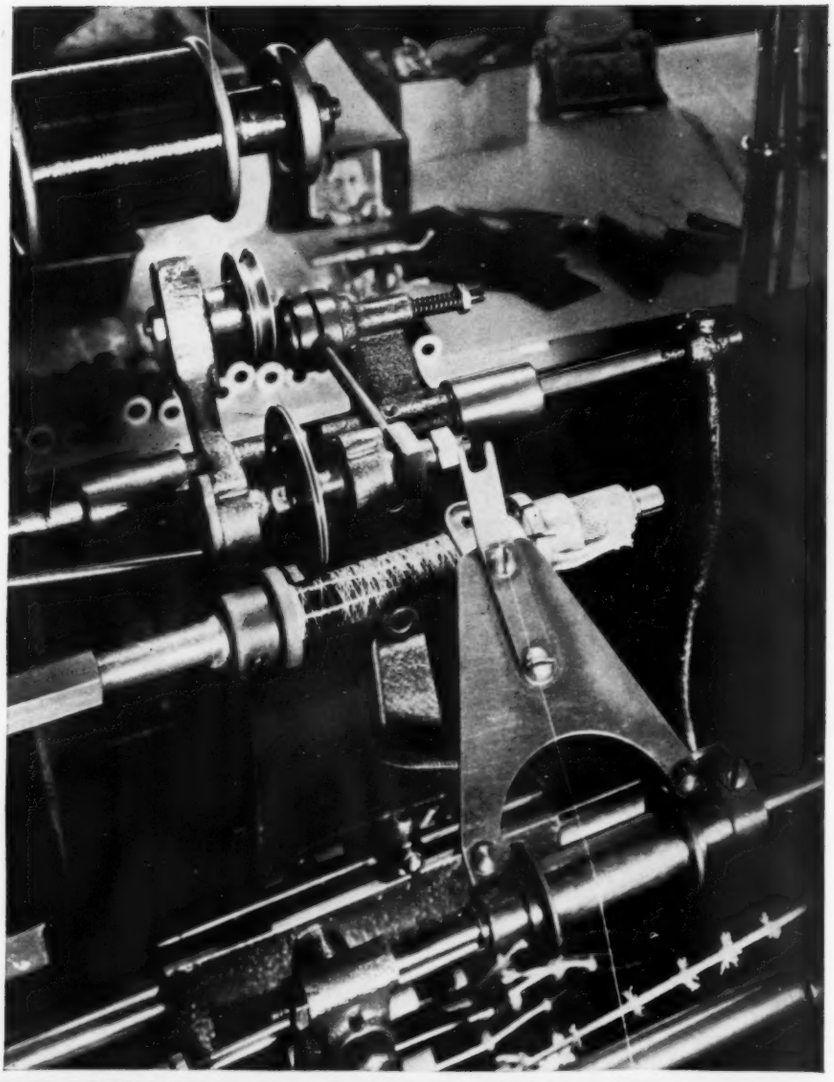
At Endicott one man in every ten is an inspector. Their collective sole duty is to maintain the standard of quality on I.B.M. products.

COUNTER UNITS *are checked on master bases which provide all the functions of the finished machines*

FINISHED MACHINES *with covers in place are given a final working test covering all operations which will be performed in the customer's office*

KINKS IN COILING

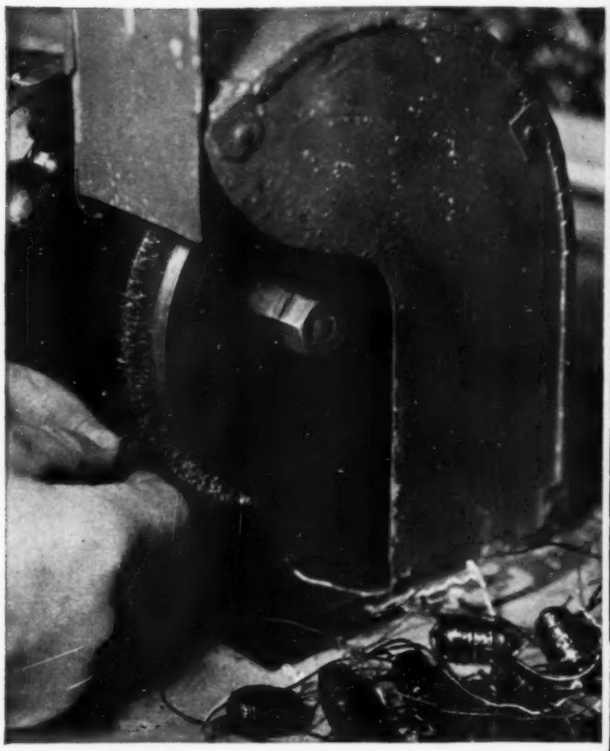
MORE THAN 1,020,000 cotton-interwoven coils were delivered to stock during 1936. All of these were wound, dipped, baked and inspected in the coil winding department. Coils are 100 percent inspected before and after the varnish treatment; only 0.7 percent of last year's production was rejected during inspection.



COTTON-INTERWOVEN COILS, *wound on a relatively heavy tube, are used because they do not require a bobbin—space is at a premium. Most of the coils contain 5,000 to 8,600 turns of enameled wire, a few coils require as many as 21,000 turns*

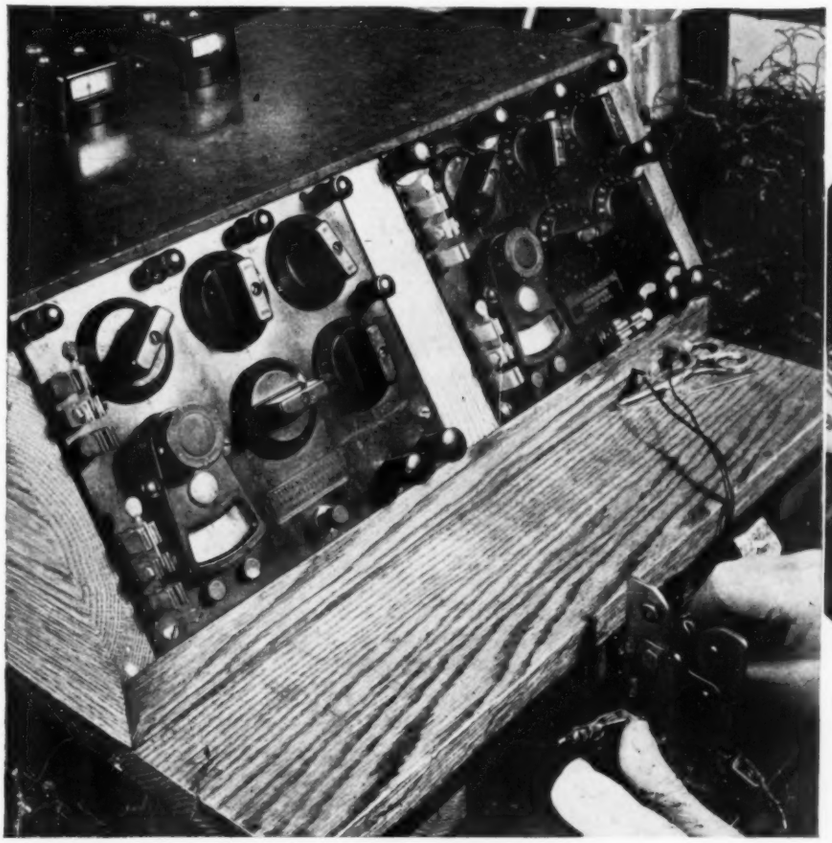
CLOSE RESISTANCE SPECIFICATIONS *necessitate accurately measured lengths of silk-insulated nichrome wire around the coil. A measuring wheel is used to determine the length of wire used*

LEADS AND CONNECTORS *are applied when coils are ready for delivery to stores-stock*



DIPPED AND BAKED *twice each coil is then dipped twice in air-drying varnish. This is followed by cleaning the core ends with a wire brush and by retapping the core mounting hole to remove the dried varnish*

JUMPER WIRE TIPS *are swaged in place in a No. 2A machine. Production is 3,000 jumper wires in 8 hrs.*



BENCH OPERATORS *bring coil leads to the outside through cotton tubes and wind a cotton covering over the entire length of the coil. No soldered connections are made inside*

COILS ARE TESTED *before delivery to stores-stock. A two-position Leeds & Northrup bridge is set for high and low limits to facilitate this inspection operation*

UNDER AN ENDICOTT STREET, *a subway constructed by the plant engineering department connects all buildings, provides a sheltered link for use in inclement weather*

PLANT ENGINEERING

Proper provision for plant services bears a direct relation to the health and productivity of the workers

PLANT ENGINEERING at the I. B. M. Endicott plant comprises both servicing and maintenance. The services consist of supplying light, heat, conditioned air and power, keeping the buildings clean, including janitor work, guarding the plant and operating the elevators. Maintenance, of course, consists of keeping all equipment and buildings in good repair and includes the lubrication of all operating machinery.

NEW CONSTRUCTION

The plant engineering department has also undertaken a number of major construction projects, the most recent of these being the company's new golf course. During the past six years this department has added two wings to the main manufacturing building, and has built the laboratory office building, the I.B.M. school building and a subway connecting the latter two buildings with the factory. Operations of this magnitude require a staff of electrical, mechanical and civil engineers and architects.

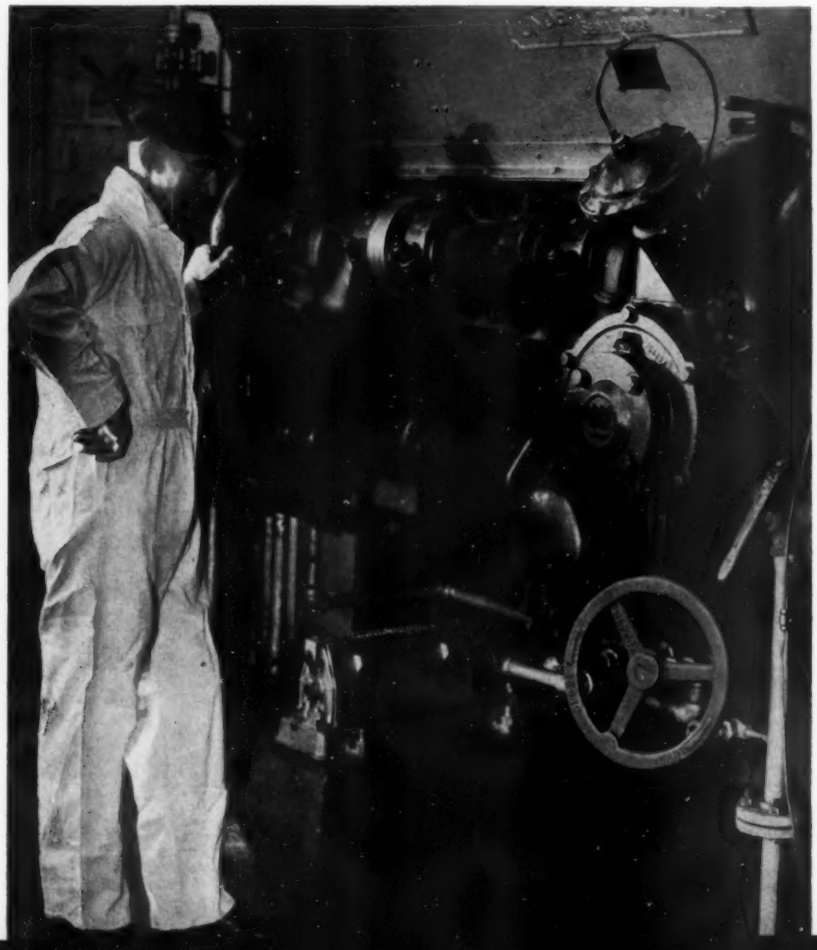
The Endicott plant purchases alternating current but generates its own direct current. Last year a total of 2,823,000 kw.-hr. of current was used for power and 2,545,000 kw.-hr. for lighting.

A new boiler house, also constructed by the plant engineering department, has recently been added. It is equipped to weigh, handle and stoke the coal and dispose of the ashes mechanically. The boiler house is so constructed that it can be extended to increase capacity if need be. At the present volume of operations, it consumes about an average of three carloads of coal weekly. The boiler house contains one new 800-hp. boiler, which is operated at 150 per cent of its rating, and two older 500-hp. boilers which are held as standbys.

A Skinner uniflow engine is used for generating direct current. Two older compound engines are kept in standby condition. Use of alternating current is increasing because as a general rule new machine tools are purchased with individual motors using a. c. current.

All power house operators wear white uniforms. The plant buildings, which cover 591,000 sq. ft. of floor area, are heated by the use of exhaust steam. The power house also supplies compressed air to all parts of the plant.

Three separate air conditioning systems at Endicott serve respectively the engineering laboratory building, the paper testing labora-



MECHANICAL COAL HANDLING *is but one of the modern features of the new boiler house, manned by a white-uniformed crew*

tory and the main machine shop of the factory covering the ground floor of six buildings. With the exception of that for the paper testing laboratory these installations were made primarily for the comfort of the workers rather than for the improvement of the process. It has developed, however, that air conditioning in benefiting the workers' health has also contributed to the quality of their workmanship.

CONDITIONED LABORATORY

When the engineering laboratory building was constructed in 1932 it was decided to provide cool air in the summer at the relative humidity best suited to comfort and warm air in the winter with moisture added. The main unit in this building, which was built by the Niagara Blower Company, is designed in the summer to reduce the temperature 10 F. below outside dry bulb temperature with a minimum of 75 F. and a relative humidity of 40 deg. In winter a temperature of 72 F. is maintained with a relative humidity of 20 to 40 per cent depending on the outside temperature but low enough to prevent excess condensation on the windows.

Conditioned air from this system is distributed through ducts to all parts of the building by a central fan. Recirculated air is returned through the corridors to the fan room.

In the paper laboratory, tests are made under varying humidity and temperature conditions of all paper stock used for tabulating cards, time cards, bank checks and special forms. The temperature may be varied from 40 to 100 F., and relative humidities from 100 to 15 per cent. The cooling system for this unit employs a Baker ammonia refrigerating machine which cools a brine tank from which the brine is circulated.

Because of the high heat loads from machines and occupants, the ground floor of the manufacturing plant, with a total manufacturing floor area of about 80,000 sq. ft., had been difficult to ventilate. It had been found that the number of colds treated for men in the machine shop was far greater in proportion than for the rest of the factory.

INDIVIDUAL UNITS IN SHOP

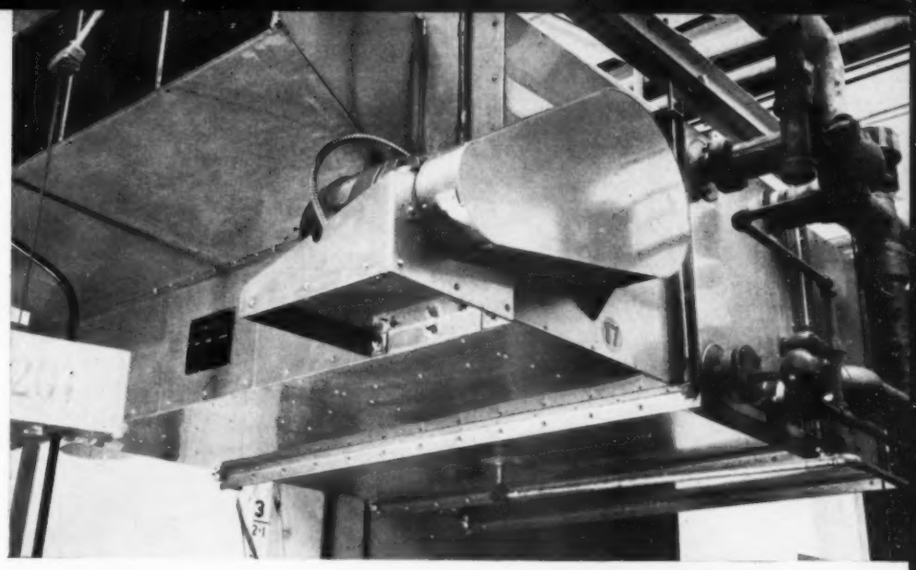
When air conditioning was installed in this area, small individual units were decided upon because of the interference ducts would cause to line shafting, pulleys, conduits and hoists. Of the 29 units used, six are fresh air units and 23 are recirculating units.

Since exhaust steam was available in large quantities in the summer time, a vacuum refrigeration system was employed for the machine shop. Well water is pumped three-quarters of a mile to the plant through a 12-in. cast-iron main supplying 1,200 gal. per hr. to the flash tank. Wells are drilled to a depth of 165 ft.

Based on the time the units have been in operation in the machine shop the dirt taken from the recirculating units is estimated at 935 lb. per year. Seventy-one per cent of the dirt taken from the filters is iron dust, and 19 per cent is oil; the rest is cotton, lint, soot and wood dust. There is also approximately 100 lbs. of dirt removed each year from the fresh air units.

Since this system was placed in operation treatment for colds in the machine shop has decreased 50 per cent.

The service men who clean the buildings work mostly at night, as this arrangement involves less interference with production. Guards



RECIRCULATING UNITS *cool the machine shop in summer, take half a ton of assorted dirt from the air in the course of a year*

AT ALL HOURS *the Endicott plant is protected by a corps of sixteen uniformed guards*

PAINTING AND OILING *are never-ending tasks in maintaining shop appearance and efficiency*

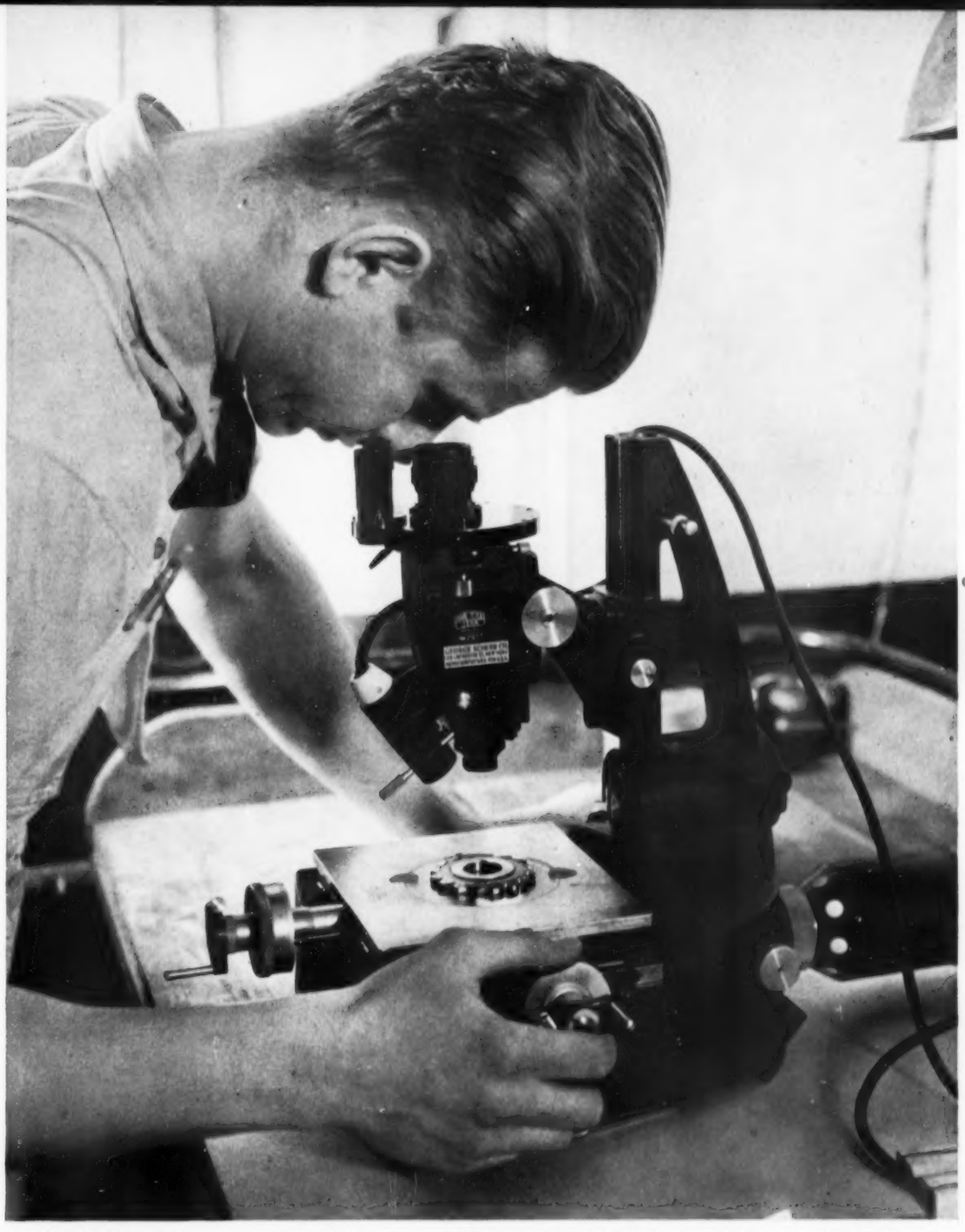
are uniformed and, while protecting all plant properties day and night, are on the lookout for the safety and comfort of employees and visitors. The sixteen men in this crew, in addition to their other duties, have supervision of the parking lots.

The maintenance crew takes care of all equipment repairs and the upkeep of the building. It also performs all departmental rearrangement from plans originated by the office personnel of the plant engineer. Approximately 90 men engaged in this work represent many trades including electricians, millwrights, plumbers, sheet-metal workers, machine tool repairers, carpenters and painters. Each group has its own foreman.

There is a regular routine for machine lubrication that has been carefully worked out. Every Saturday, plant operating equipment is thoroughly cleaned. Periodically all machine tools and other plant equipment are repainted, group by group.

Spare parts for practically all operating equipment are maintained in a maintenance stockroom which is equipped with modern steel shelving. In addition, the plant engineering department has its own maintenance machine shop which is capable of making special repair parts and also machine guards. The men in this department have developed a number of guarding devices that have proved particularly effective in promoting safety. Altogether there are 525 machine tools in the plant which must be maintained, lubricated and repainted by the plant engineering maintenance group.

IN ITS OWN STOCKROOM, *the maintenance division keeps replacement parts for speedy service*



FORM TOOLS, *cutters and gages can be accurately inspected with the aid of a Zeiss toolmaker's microscope*

AS GOOD AS ITS TOOLS

Believing that tools are the basis of quality, I. B. M. provides for tooling as it plans its product

TOOLING at I.B.M. begins with the design of the product itself; that is to say, each part, unit or machine, as it leaves the drawing board in preliminary form, is given a manufacturing analysis to make certain that it is adapted to efficient processing. If this study indicates that changes are desirable, the part is redesigned to conform to modern shop methods. The men who do this work are experienced in planning and shop procedure. Their recommendations are incorporated in the design before final approval and tracing. Thus redesign of parts already in process is usually avoided by anticipating manufacturing requirements.

After a design gets final O.K. it is sent to the planning division of

the manufacturing engineering department. This design may include a complete machine, a machine unit or simply a single part. In any case, it is scrutinized by a tool analyzer, who outlines the tooling required. In so doing he considers not only the operations needed to make the part to the limits specified but also the quantities demanded, the material used, the quality of finish and whether or not heat treatment is called for. The tooling may be temporary, semi-permanent, or elaborate depending on quantities.

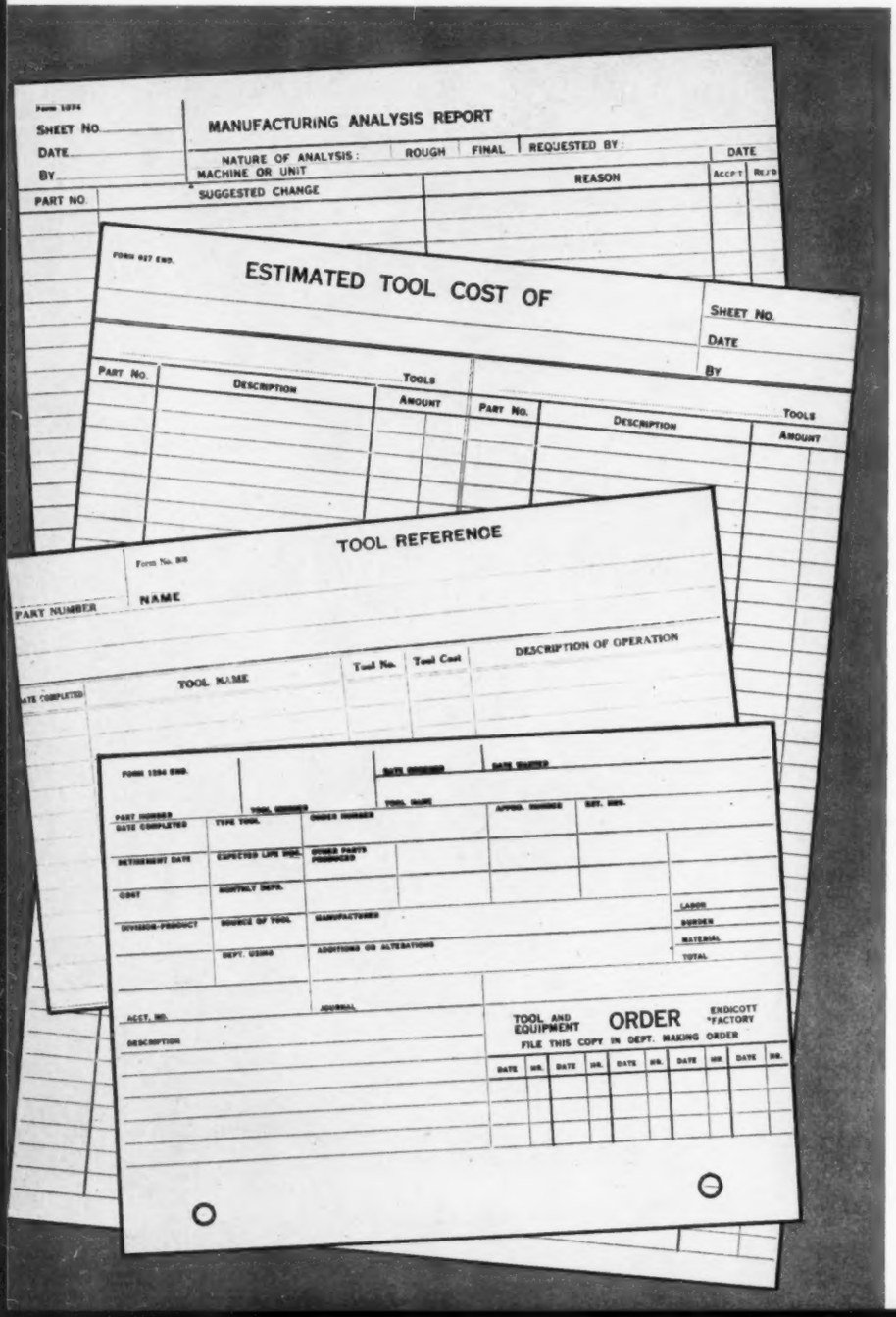
The tool analyzer weighs the possible methods in his mind and in most cases can reach the proper procedure from his own experience. If he has any question concerning the choice of methods, he confers with the chief tool analyzer who in turn may seek the advice of the assistant manufacturing engineer. In particularly knotty cases the manufacturing engineer is called upon and the four men sit down together and decide upon the procedure they consider the best.

When the tooling is determined, the tool analyzer makes a preliminary estimate of tool cost. This is not a detailed figure but rather a good guess based upon his knowledge of similar tools. The cost estimating department also prepares a rough estimate on product costs. Both these estimates are submitted to the manufacturing engineer.

At this point it may be apparent that the cost is too high. The tooling called for may be too elaborate for the quantities needed, and a more simple set-up may be advisable. But if everything seems in line, the procedure is approved and the tool design order is issued.

Detail designs are drawn up in conformity with the approved proposals. When these have been completed, a final tool cost is estimated, and the order to build is released to the toolroom or to an outside vendor as the case may be. In either event the tool supplier is considered to be a contractor, working to the blueprint and specifications of the planning department.

TOOL PARTS *come to the bench already machined, leaving only assembly and finishing touches to the toolmaker*



FOUR OF THE MANY *forms used by the planning division are respectively: (a) analysis of new units going into production; (b) estimated tool costs of units going into production; (c) tool reference card which identifies all the tools required to make a specific part; changes and replacements are noted on the back of this card; and (d) shop orders for tools, a tabulating card copy of which goes to the accounting department for the inventory file*

THE TOOLROOM

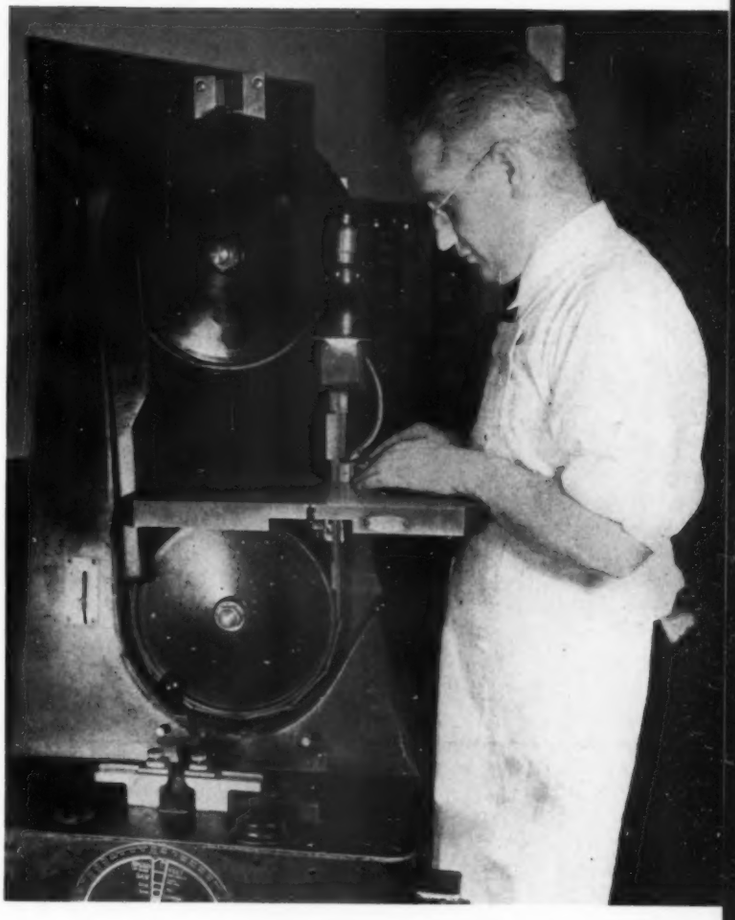
A few years ago I.B.M. purchased the larger part of its tool equipment with its toolroom working chiefly on tool maintenance and repair. Today outside purchases are largely confined to standard tools such as

drills, reamers, milling cutters, taps and hobs; the tool room makes most of the dies, jigs, fixtures and special tooling.

When an order goes to the toolroom it is accompanied by requisition cards for the stock required on standard I.B.M. card forms. A colored stripe on the card indicates whether raw material (yellow) or semi-finished stock (orange) is called for.

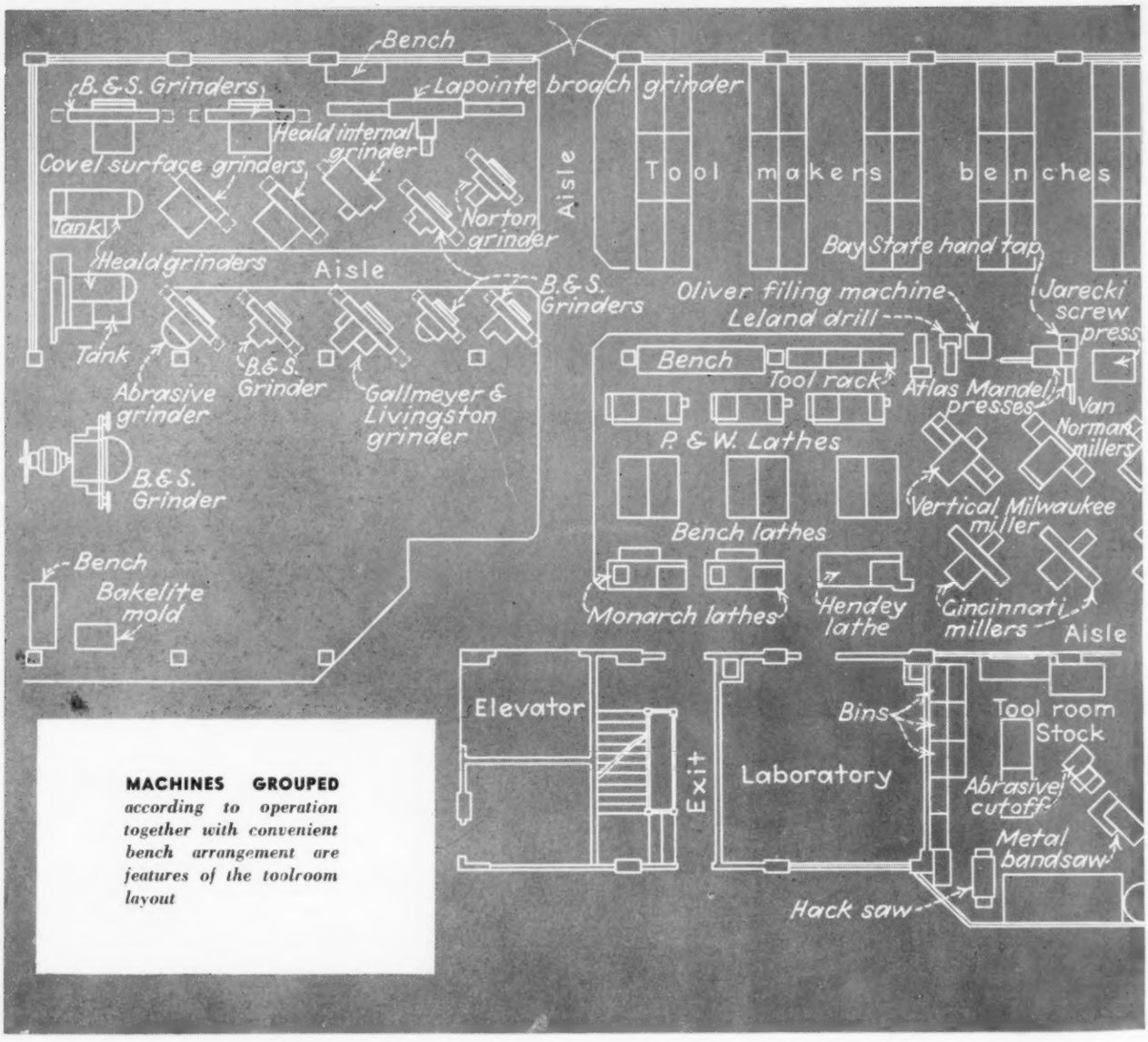
For convenience in administration the toolroom and the special production shop are concentrated under the supervision of one man. The special production shop builds model machines and small lots of special machines on which tooling would not be justified. The combination of these two departments allows a desirable degree of flexibility in personnel and equipment which aids in balancing the work.

The toolroom is divided into machine groups; that is, there are milling machine, grinding machine, lathe and bench divisions within the toolroom. Jobs are distributed to group leaders of these divisions who in turn assign particular parts to the machines. The men at the machines are high grade operators capable of setting up their own work while those at the benches are toolmakers. When details have been processed they are delivered to a toolmaker who carries the unit through to completion. Often he will have some



A SET *of needed small tools is supplied by the company, but each toolmaker has his own box containing calipers, mikes, and other equipment of the trade*

MACHINE SAWING *and filing reduces handwork in turning out small parts in the toolroom*



MACHINES GROUPED *according to operation together with convenient bench arrangement are features of the toolroom layout*

CARE IN TOOL *sharpening has much to do with maintaining quality in the product*

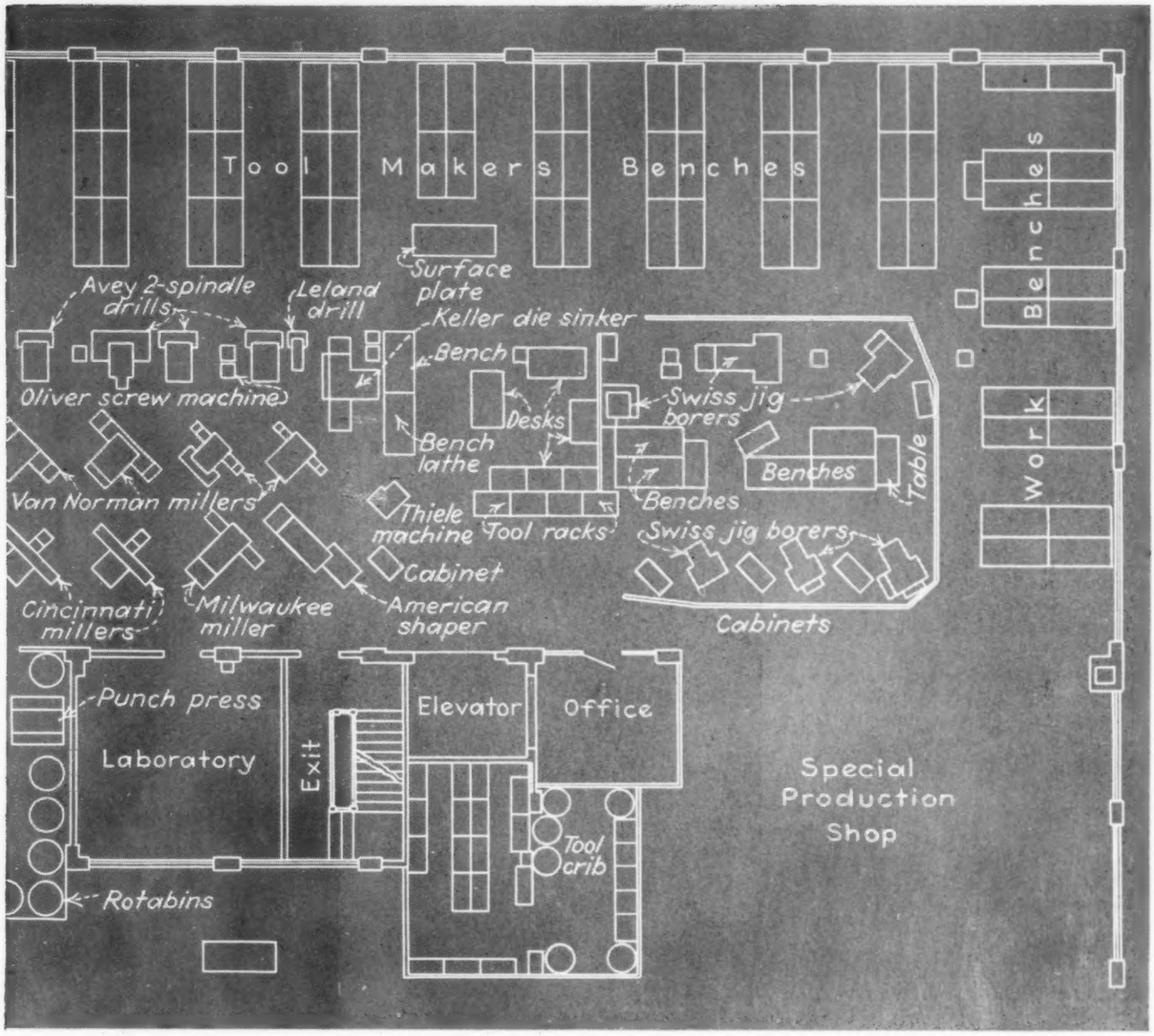
additional machine work to do for fitting or adjustment, but the bulk of the machine work has already been performed.

In addition to its work on new tools, the toolroom takes care of tool maintenance and tool changes. Changes may be ordered because of product change or because of some weakness or improvement in the tool that has developed during its use. Broaches, form tools and other special tools are sharpened in the toolroom.

Each toolmaker has his own tool box with a complete set of measuring equipment. Both the box and toolmaker's tools may be bought from the company at cost. In addition each toolmaker has a set of drills, reamers, counterbores and taps which are left at his bench in a set of drawers under lock and key.

The toolroom, in conjunction with the special production shop, has its own tool crib and its own material stockroom. The tool crib contains cutters, special gages and other tools which are issued to the men on written requisitions. As these requisitions are received they are put into a small compartment marked with the man's number and one of his brass checks is taken from a hook in the compartment and placed in the bin from which the tool was taken. When the tool is returned the check is returned to the hook, and the signed slip is given back to the man.

The toolroom carries some seven to ten tons of steel in stock marked in color code to indicate its composition. Drill rod is kept in a specially designed Rotabin. A bandsaw, a hacksaw and an abrasive cut-off wheel are provided to cut the stock as needed. In addition the stockroom contains standard parts such as screws, bushings, knobs, springs for dies, die sets, strippers, automatic



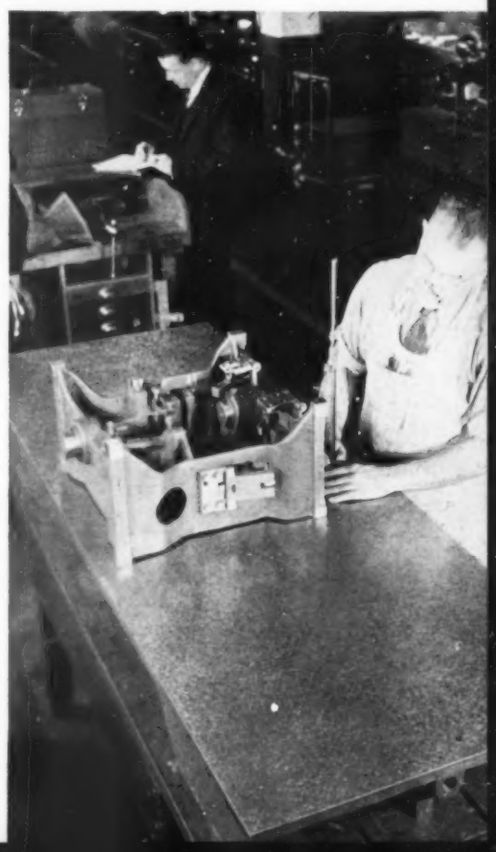
stops, knobs, dowel pins and plates for drill jigs. Standard springs and bushings are purchased; other parts are made in lots and issued as required. Die blocks are made in lots of 25 or 50. The aim is to put toolmaking as nearly as possible on a production basis.

There are six Swiss jig borers used jointly by the toolroom and the special production shop. These machines are employed on regular jig and fixture work and also on small lot production work where quantities do not permit tooling and where duplicate orders are not anticipated.

TOOL INSPECTION

From the toolroom, tools go to the tool inspection department which is under the general supervision of the inspection supervisor. Here all tools are checked 100 per cent before being released to the production departments. Of the twelve men in this section, certain ones specialize on dies, gages, jigs and fixtures, and form tools respectively. These men are all skilled toolmakers. Tools from outside vendors are examined as well as those from the I.B.M. toolroom.

A master record card is kept in this department which forms a listing of the tool as regards quality. If dimensional or other corrections are required these are noted on the card before the tools are sent back to the toolroom or vendor. Also tools from the production department which become worn or otherwise inaccurate with use pass through tool inspection before going back to the toolroom for repair. In fact the tool inspection foreman originates all orders for tool repair. This department handles tools being returned for engineering changes and checks these changes after they have been made.



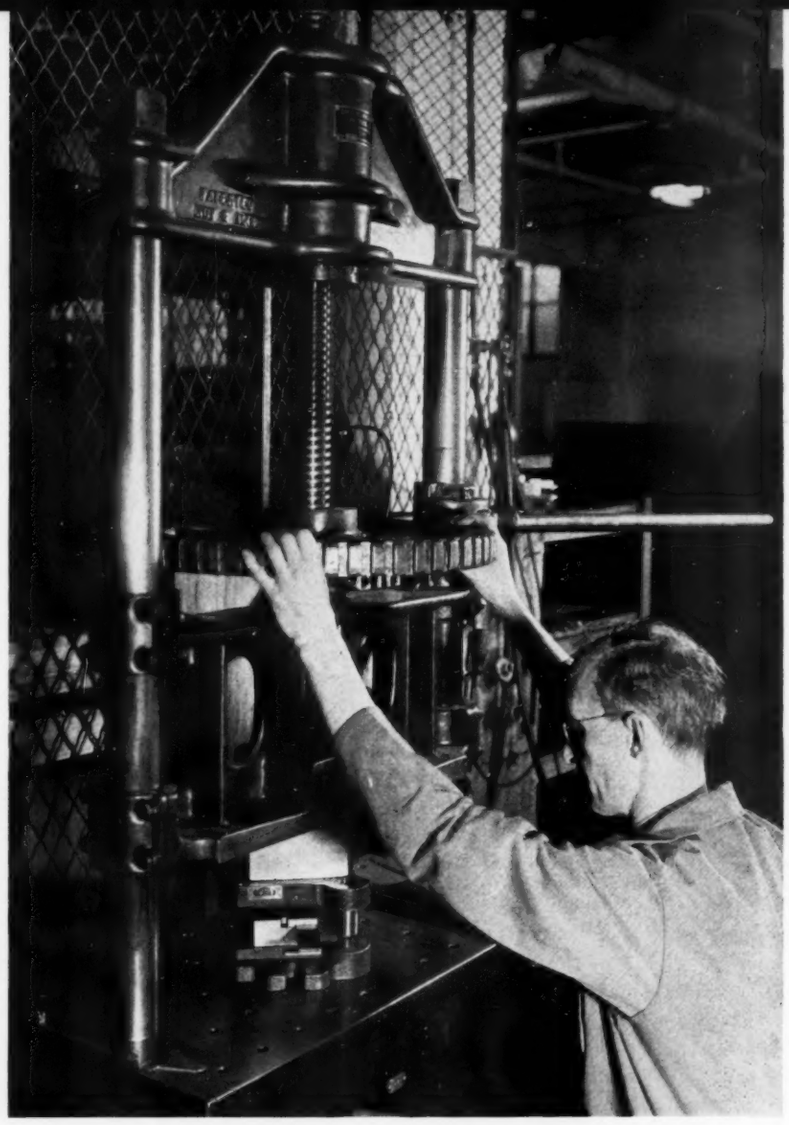
A LARGE SURFACE *plate aids accurate alignment in jigs and fixtures*

All dies are made to produce sample parts before being O.K.'d. An inclinable V. & O. power press is used for trying out heavy dies, and a hand screw press for light dies. A rack of sheet metal samples is kept for all dies that pass through tool inspection for comparison with production parts when necessary.

Tool orders from the planning department are sent here in duplicate. One copy is kept on file, and the other is forwarded to the toolroom with the material requisitions.

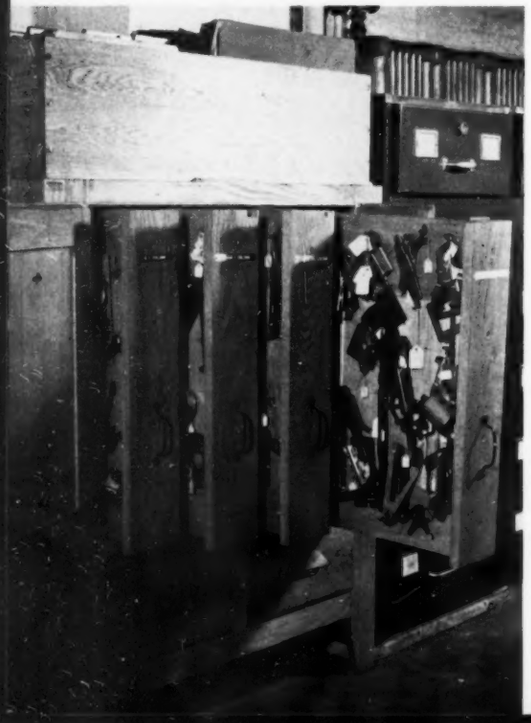
Each inspector has a surface plate, surface gage and his own set of precision measuring instruments. Two sets of Hoke gage blocks furnish the standard by which all instruments are checked. For taps, reamers, small form tools, small templets and angle gages a Zeiss toolmaker's microscope proves useful. This instrument accommodates both flat tools and tools which are supported between centers. A Rockwell hardness tester is used to check all tool parts which require hardening, such as jig bushings and punches, locating blocks, etc. This independent tool inspection is considered one of the important units in maintaining product quality.

About 60,000 tools, including jigs and fixtures, are kept in the main tool crib or storage. Press dies are not stored here and are not included in this figure. This department is situated one floor below the main machining departments. A small crib for issuing and receiving tools on the main machine floor is connected with the main crib by a spiral stairway and a tool elevator.



SMALL DIES *are tried out in a screw press before they are finally approved*

SAMPLES OF STAMPINGS *from all press tools are kept on file in the tool inspection department*



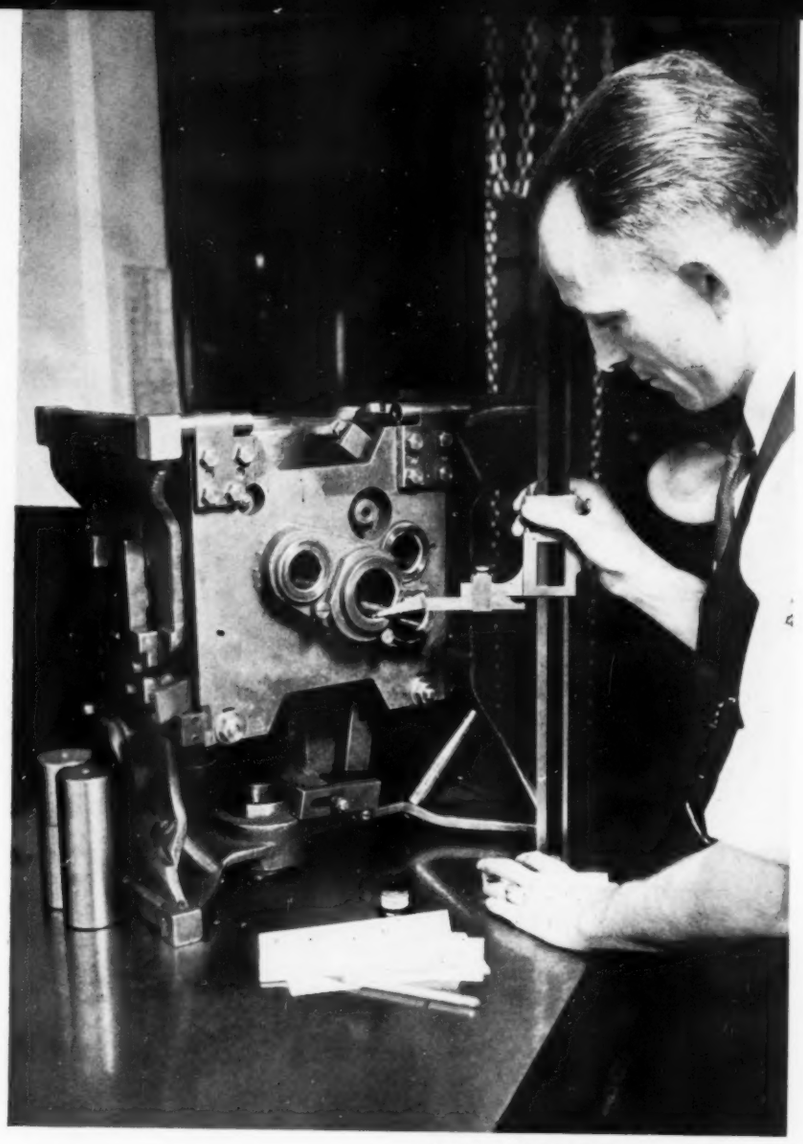
Requests for tools are made out in duplicate and are handed in at the upper crib. One copy is filed with the operator's check against the number of the machine he is working on. The other copy is sent down a chute to the main storage crib. This copy is put in place of the tool that is removed from the rack. Tools are ordered ahead of the job set-up so they will be ready and issued before the operator has need of them.

All steel bins are used for tool storage. The larger tools are kept in straight steel bins, and the smaller tools are kept in Rotabins. For the class of storage to which they are suited it is estimated that the Rotabins save 40 per cent in floor space and 75 per cent in the time of looking for the tools above the old racks formerly used. These bins have removable partitions so they may be divided as required. Some of them are provided with drawer sections. Three of the 90 Rotabins are inclosed so that certain small tools such as drills, reamers and files may be kept under lock and key.

A card file is kept of tool locations according to part number. Each card gives a location such as 6B1 which indicates section, shelf and compartment. When several small jigs and fixtures are kept in one compartment it is the practice to keep unlike units togther, such as a drill jig and a milling fixture, so there will be little danger of confusing them.

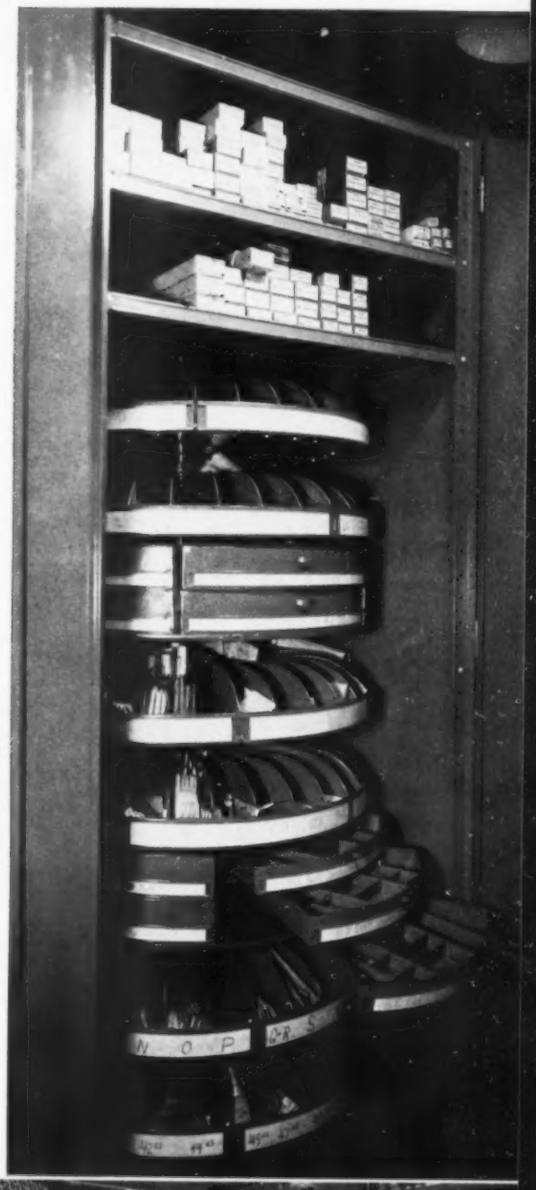
When a foreman of one of the machining departments returns a tool he tags it with a green slip if it is O.K. and a red slip if it needs repairs. When repairs are called for, the tool is sent to tool inspection.

Standard small tools after being issued to the machining departments are retained and sharpened in the



TRAINED INSPECTORS *carefully check all tool equipment before it is released to the machining departments*

INCLOSED ROTABINS *are used in the tool storage section for standard small items such as drills, taps, reamers, files*



departmental crib and are not returned to the main tool storage. If a drill jig, for example, has finished a lot of parts the jig goes back to storage, but standard drills, taps and reamers go to the departmental crib for sharpening. Special equipment, however, is returned with the jig or fixture.

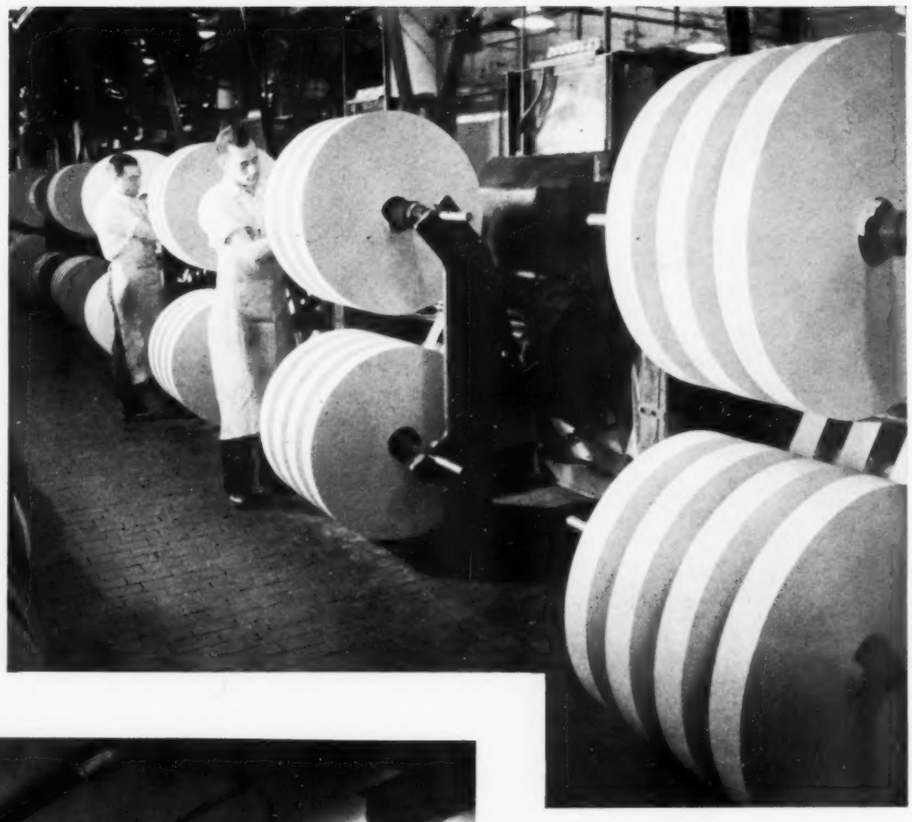
The largest departmental tool crib is the one that serves jointly the milling and drilling machines.

Each machine has an exhaust duct to keep abrasive dust out of the shop. Trained tool men work steadily in this crib to serve the milling and drilling departments.

The screw machine department has its own crib for storage. In this department the operators do their own sharpening, and two tool grinding machines are available for this purpose.

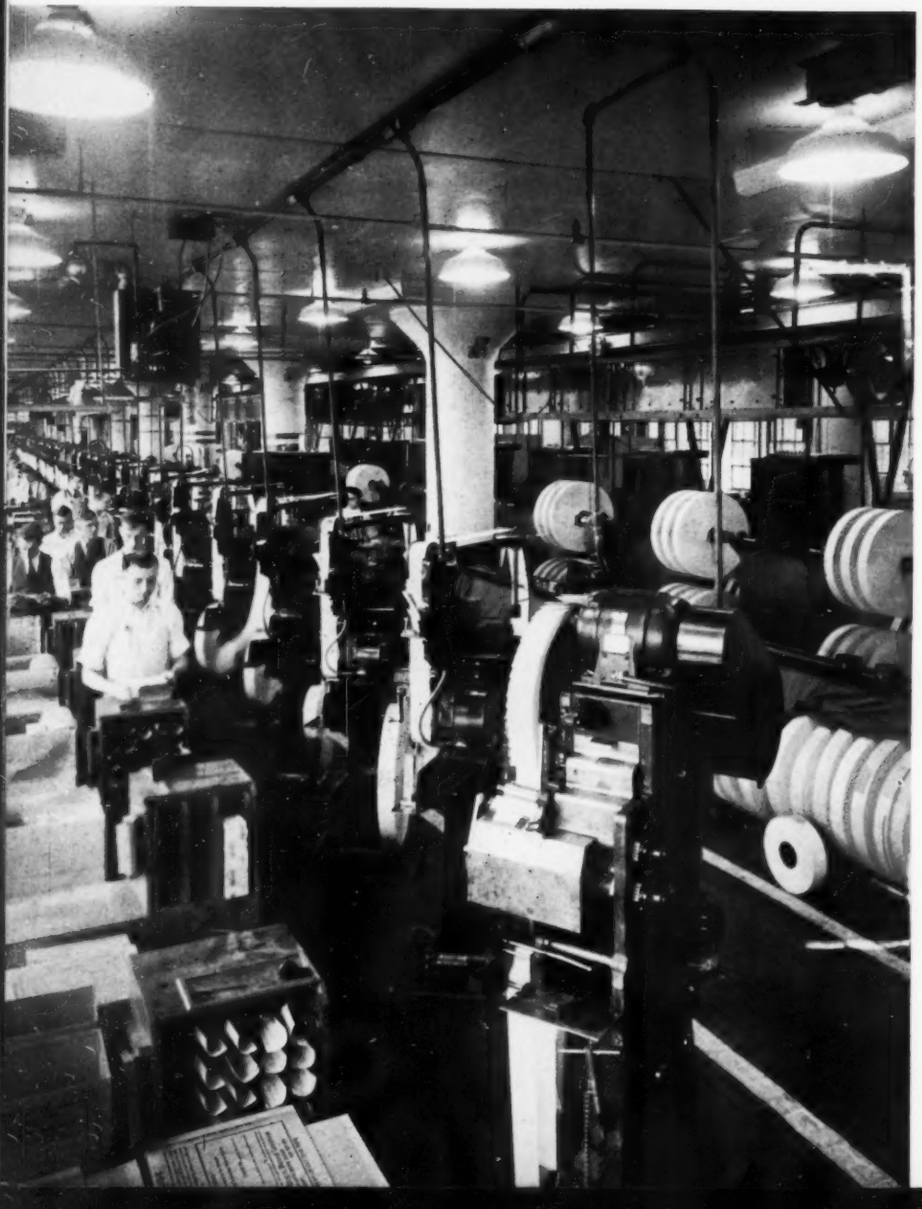
The gear cutting department also stores its own tools. A hob grinder is installed in the departmental crib to keep these tools in good shape.

A SEPARATE CRIB *serves the toolroom and special production department*



INCOMING PAPER *must first be slit to the correct width for I.B.M. cards. Strips are held to plus 0.007 minus 0.005 in. on the width*

SLIT PAPER *moves across the aisle to high-speed Carroll presses. The machine in the foreground is the new 700 Series. Inspected cards are put in the waiting boxes. A gravity roller conveyor at the left of the picture takes the boxes to the packing department at the rear*



CARDS FOR CUSTOMERS

Domestic and some foreign requirements for tabulating-machine cards are filled in a highly organized plant

THE PUNCHED card is the heart of the I.B.M. system of tabulating machine operation. To satisfy the needs of its many customers both here and abroad, it is necessary that the corporation print millions of standard and special cards per day. Printing of the cards is in itself a huge operation, but this is coupled with paper research, handling and storage of bulk paper, packing of printed cards for shipment and special jobs.

The card plant consists of a basement storage room for paper, and a

street-level floor for printing. Rolls of paper for ordinary cards are stored in an open room, the supply of both white and colored materials being maintained at a three-months backlog. Watermarked bank paper is kept under lock and key and is weighed in and out to prevent improper use.

CYLINDRICAL TYPE

Cylindrical type rollers for the card-printing machines are also kept in the basement. When an order is received for a particular card, the clerk refers to an index file, and then pulls the correct type from the racks. These rollers consist of hollow brass cylinders similar to a dictating-machine cylinder but shorter. They are made of brass, etched to suit the printed matter required and then chromium plated to increase the wear resistance.

Paper removed from storage goes first to the slitting machines. These cut 23 in. rolls into seven strips, 26-in. rolls into eight strips. The width of strip is held to plus 0.007 minus 0.005. Here a very interesting inspection operation is performed automatically.

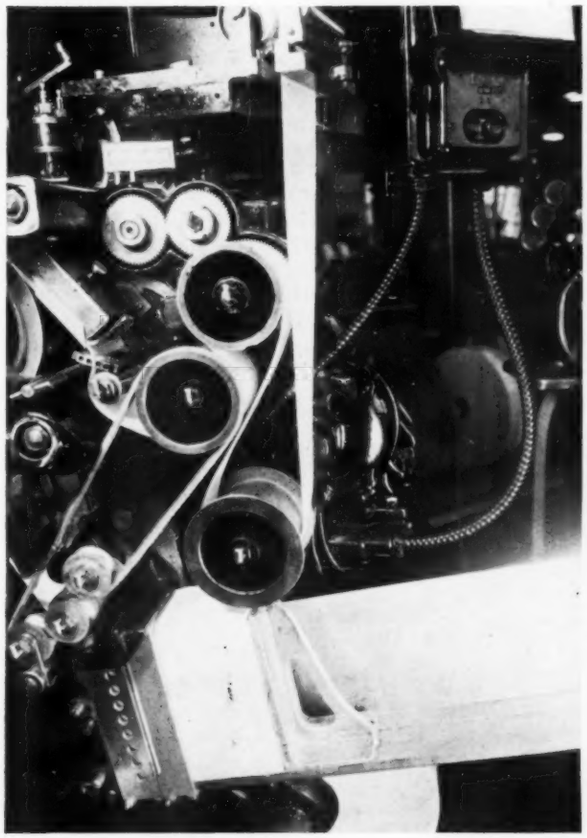
ELECTRICAL INSPECTION

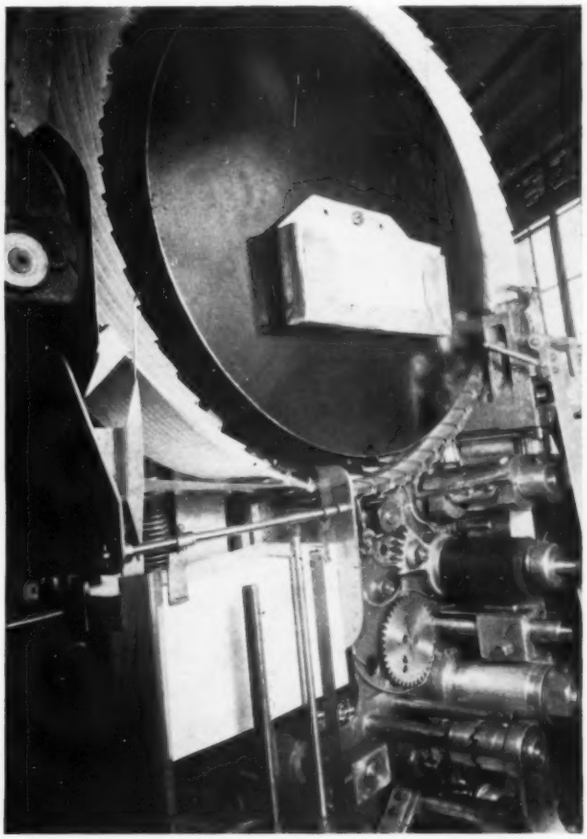
The principle of I.B.M. card tabulation is that wire brushes carrying an electric potential are rubbed down one side of the card. When the brush passes over a punched hole it makes contact with the contact roll over which the card passes. A current passes through such a brush and actuates, by means of relays, proper counters or printing type in the tabulating machine.

Any conductive material, such as carbon specks in the texture of the card, could permit faulty operation of the machine on passage of the card. The defective cards must be removd for satisfactory operation of machines.

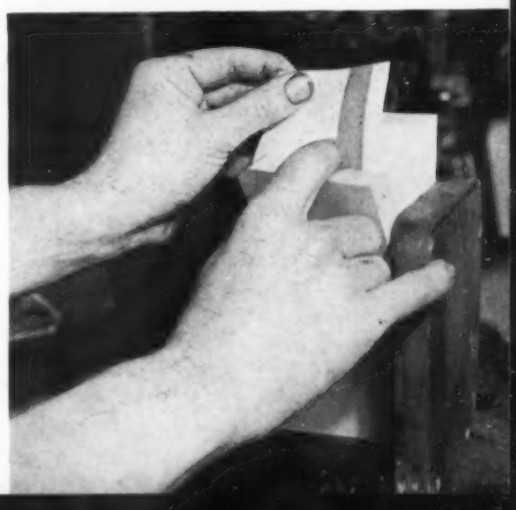
This is done as follows: at the upper part of the slitting machine, the uncut sheet is run over rollers and down in a vertical path between a plate with a potential of 220 volts and brushes on the other side. When a carbon speck comes along the passage of current between the plate and brushes causes a Thyratron control to actuate an ink dauber. This dauber stains the defective portion of the strip with a brilliant red dye for a short distance. Inspection of printed cards quickly throws out those which have been painted on the back.

The slit paper is taken to Carroll high-speed presess so named for the

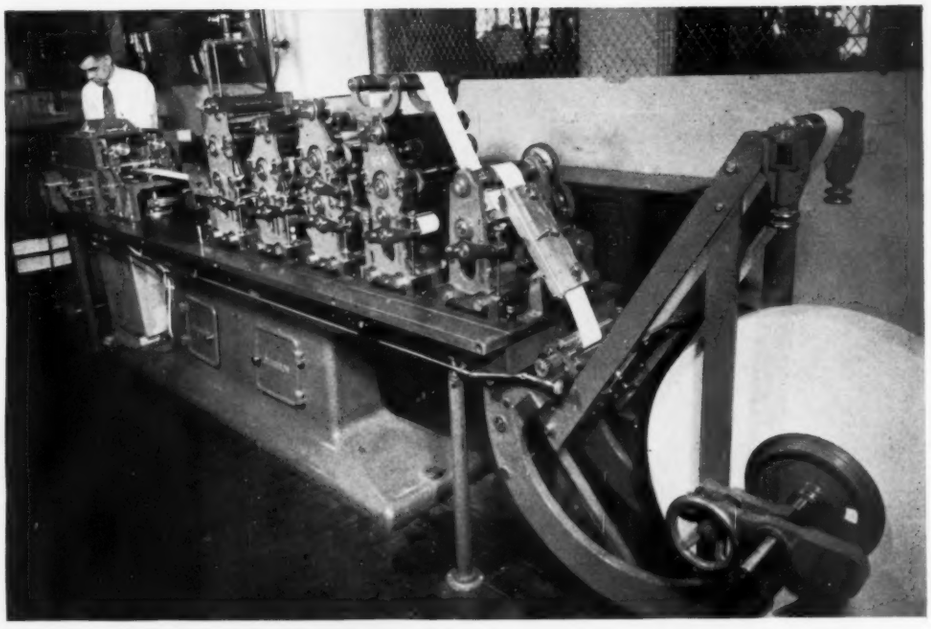




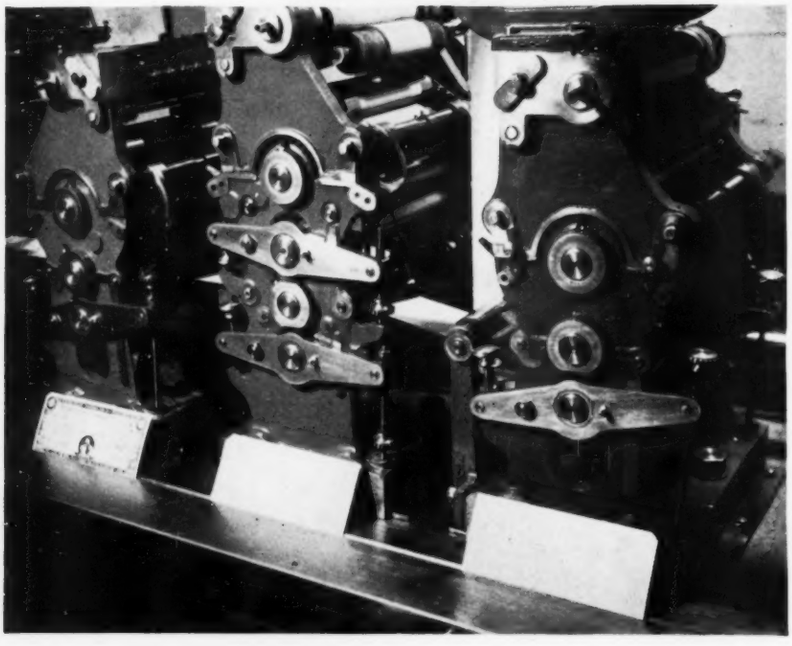
PRINTING TECHNIQUE *receives the same development as manufacturing methods in other departments. These close-ups show stacking mechanisms of the 300 Series press at left and the 700 Series at the right. On the latter a drum allows longer drying time and smear proof stacking*



A RED DAUB *on the back means a defective card. The daub was applied on the slitting machine*



TWO YEARS *of intensive development produced this press for checks and admission tickets to sporting events. This single machine combines all operations that require an operation split up if done on the older units*



PRINTING SEQUENCE — *starting at the right: endorsement on back, tinting on the face, and printing the face of a check*

I.B.M. engineer who designed them. There are 32 of these machines installed in the printing department, 31 of the 300 Series and one of the 700 Series. Both of these machines print the card on the roll, cut it off and trim one corner at an angle, and stack the cards.

PRESS DEVELOPMENT

The 700 Series press has a number of improvements over the 300 Series machine. After the cards are cut apart, they are inserted one by one into a rotating drum which allows them a longer interval to dry than on the 300 Series press. After moving around the drum, they are stacked pneumatically without any possibility of side shifting and without downward pressure on the back of the preceding card. These two improvements prevent blurring or smearing. On the older machine the cards are cut off and directly pushed down into a mechanical stacker.

The printed cards are removed at intervals by the pressmen and inspected for defective cards containing carbon specks. They are then sent along by the roller gravity conveyor to the packing department where orders are made up for lots of different sizes. Some orders are sent out in cartons with a waxed-paper lining and others are put in boxes. Still other jobs are sent through in soldered containers to prevent high humidity regions, such as the tropics, from ruining the cards either in transit or storage.

CHECK PRINTING

Checks, admission tickets to high-class sporting events, and other special work are done in another department. A check may require several operations, such as printing the endorsement form on the back, tinting the front and possibly the back, overprinting with the bank's name, serial numbering and pre-punching for tabulating when the payroll is audited. Usually these operations are split up among two or three different types of machines in the department. There is now installed, however, a new press that will do all of these operations at once. This machine saves considerable floor space by its use. A job can be run through in one step automatically, without additional handling.

Other special jobs are the printing of time-clock record sheets, time cards, all the corporation record forms, and the collating of I.B.M. cards with carbon-copy material.

MADE IN ROCHESTER

I. B. M.'s Electric Writing Machine Division solves its own problems, sells and services its own product

ON JULY 1, 1933, Electromatic Typewriters, Inc., became affiliated with I.B.M. as the International Electric Writing Machine Division. Manufacturing facilities of this division are located at Rochester, N. Y. So far as day to day problems of engineering and manufacture are concerned, this plant is operated as a separate unit. For the broader phases of policy this plant looks to I.B.M. headquarters.

For example, immediate engineering changes and improvements are carried out by engineers located at Rochester. This, of course, includes all tool design and tool making. The International Electric Writing Machine division has its own sales and service forces and trains men for these duties at Rochester. On the other hand, the development of new products is done at the Engineering Laboratory building in Endicott. While the sales and service men for the electric writing machines devote their entire time to this work, they operate in conjunction with the other I.B.M. sales forces and use the same office facilities.

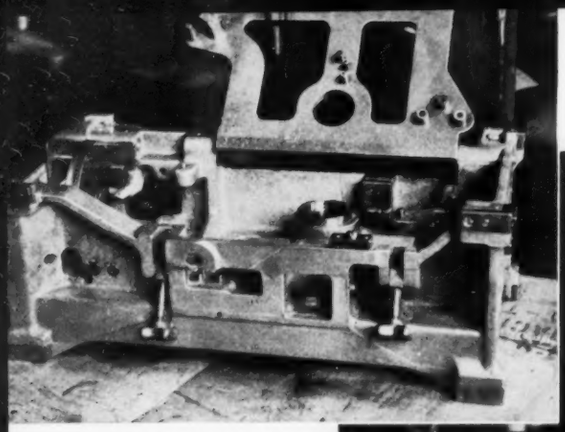
ENDICOTT POLICIES PREVAIL

The International Electric Writing Machine division functions as a separate unit, but the same personnel and safety policies are in vogue as in the Endicott plant. Identical also, are the rules and regulations as well as the benefits to the employees.

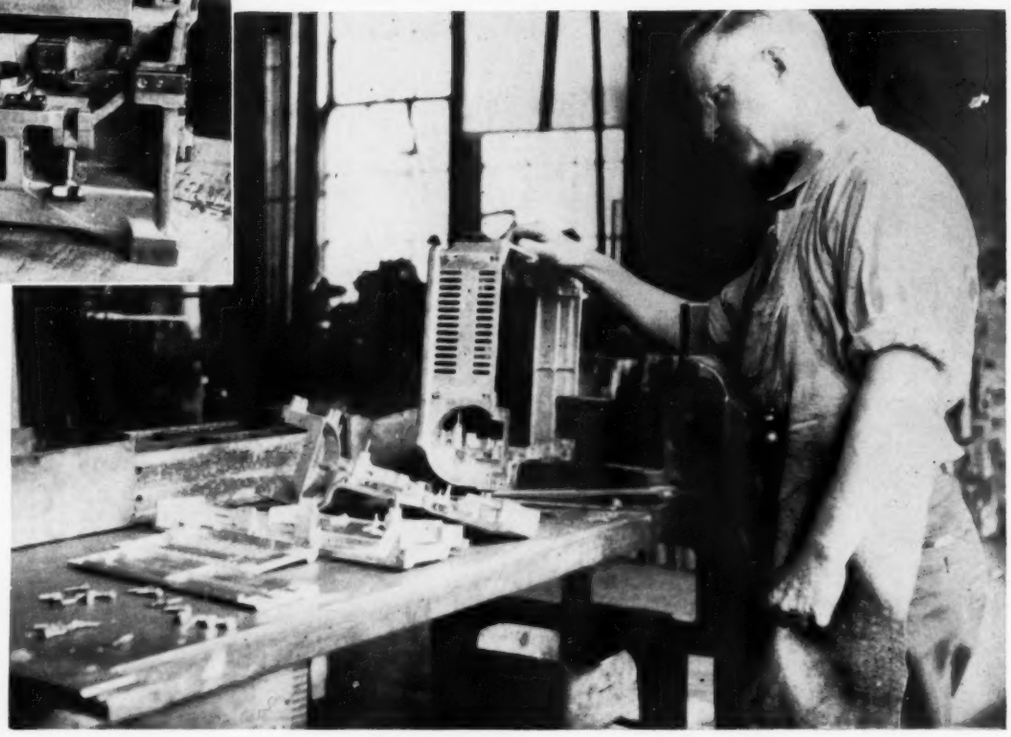
Although the writing machine made by this plant is fully electric, it is so designed that its weight, including the electric motor, compares favorably with standard makes of mechanical typewriters on the market. One of the means of accomplishing this is by the use of aluminum die castings for many of the main members. For instance, the base of the machine is made up of four aluminum die castings assembled together. The base parts are milled and jig drilled before assembly. It is interesting to note in this connection that the desire for lightness extends to the tooling, and the box type drill jigs used for the base members are made of duralumin for ease of handling in the shop. The four parts are put together on a locating fixture and are clamped while the joint holes are drilled, tapped and countersunk.

These parts are finally assembled

SALES AND SERVICE MEN *for the Electric Writing Machine division are trained at Rochester*



DURALUMINUM *box jigs with steel inserts speed the drilling operations*



THE BASE *is made of four aluminum die castings fastened together with special screws*

with shear screws so designed that the heads twist off when the screws have been seated at the proper pressure. The screws, which are made in the plant, are necked down so that they will break at the right point when driven home with a socket wrench. The sheared ends are then ground down on an abrasive wheel and polished to form an invisible joint.

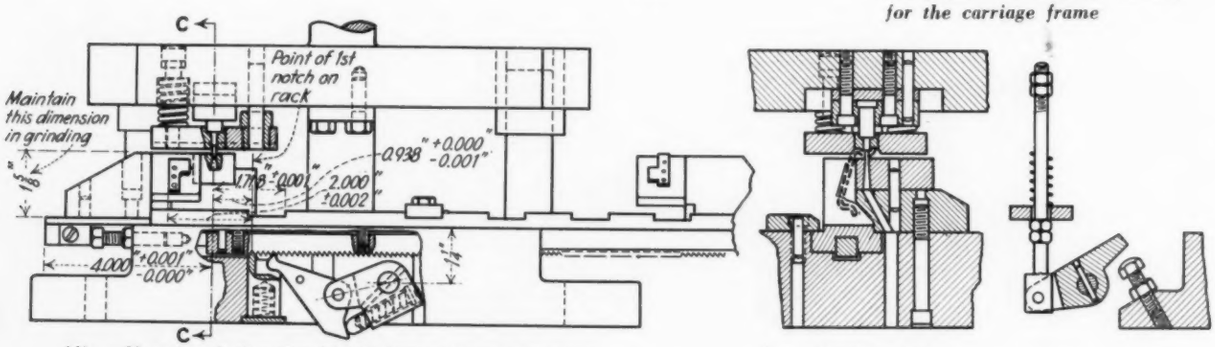
ROLLED SHAPE FOR CARRIAGE

While the writing machine made at Rochester is a standard unit, it is modified in certain parts to accommodate special business applications such as bill writing. For these special purposes the length of a carriage is often changed and may vary from the standard 12-in. carriage to as long as 30 in. The carriage is made of a rolled piece of formed steel with end plates welded to each end. These rolled shapes are purchased from the steel supplier, rough cut to length.

One of the interesting operations on this piece, before the ends are welded on, is the perforation of the carriage traverse holes. On the 12-in. carriage there are 59 holes on one side and 50 holes on the other, 0.076 in. in diameter with $\frac{1}{8}$-in. spacing. These holes are punched in an indexing die in which each stroke of the press ram actuates a pawl moving the work along for the next hole. By means of these tools, the 109 holes can be punched in less than 2 min. The longer carriages, of course, contain more holes and require propor-

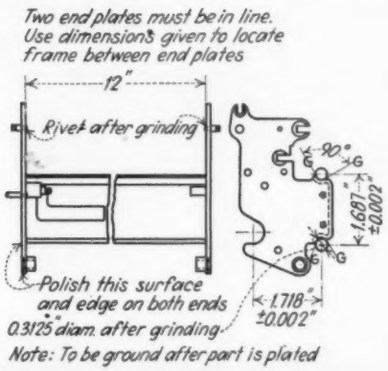
HEADS *of shear screws are designed to twist off after they have been seated by the socket wrench*

A RATCHET FEED *actuated by the press ram indexes the die for the carriage frame*



View Showing Index Pawl With Ram in Down Position

Section C-C



THE CARRIAGE FRAME *is assembled from a center rolled steel section and two pressed end plates*

AS THE RAM DESCENDS *the lower part of the die is moved one notch at a time to perforate the traverse holes in the carriage frame*

tionately more time. The press tools are shown in the accompanying sketch.

Since the same cross-section is used for all lengths of carriage, and the same end plates are used in all cases, the only variable factor is the length. When the end plates are welded in place they are held in a fixture in proper relation to the formed steel center piece. This fixture is adjustable for length and is so constructed that the correct relation between the parts is maintained. Oxyacetylene welding is used for this work.

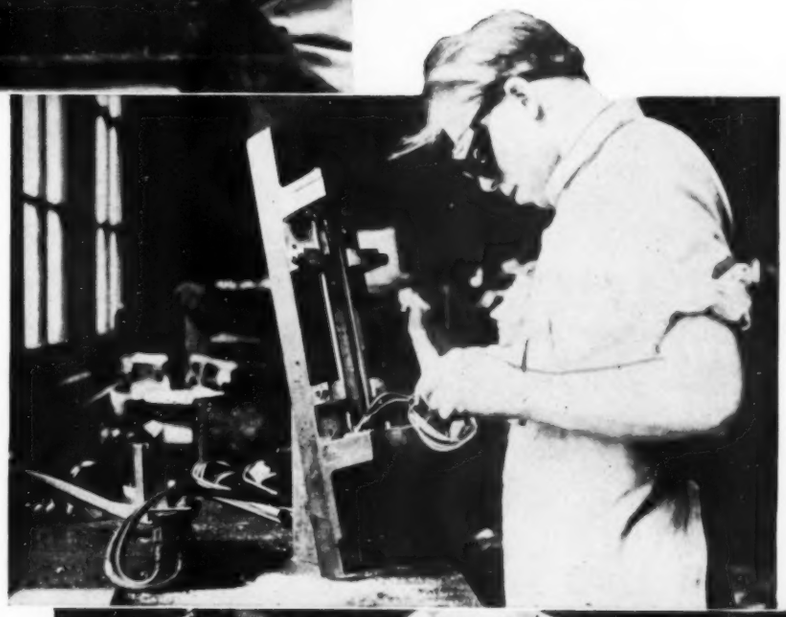
GUIDE WAYS GROUND

After a number of minor operations, the carriages are chromium plated. Then they are returned to the machining department for grinding the ball races. This operation is done on a No. 3 Abrasive grinder, using a grinding fixture to locate the work. The fixture may be tilted and locked by locating pins so that the ball races on each side of the carriage can be finish ground in a single set-up. A circular formed wheel is used with a truing device mounted at the end of the fixture. The grinder is equipped with hydraulic feed.

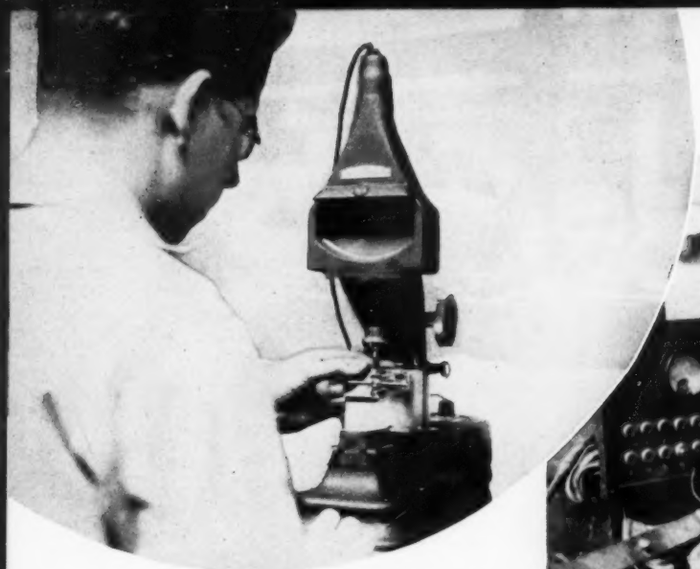
SIX-SHAVE DIE

A small part, but one that must be carefully processed, is the letter cam. This piece is part of the mechanism that operates the type bar after a key is struck; the limits required are very close. The 32-in. pitch teeth on both sides of the cam are particularly important and are cut in two shaving die operations after the piece is formed. In the operation of this die, each piece is placed on a punch which is shaped to locate it and has a spring retainer to hold it. The die itself consists of six cutting surfaces similar to a short broaching tool. Since each tooth removes only a few thousandths of an

AN ADJUSTABLE WELDING JIG *takes care of carriages of different lengths*

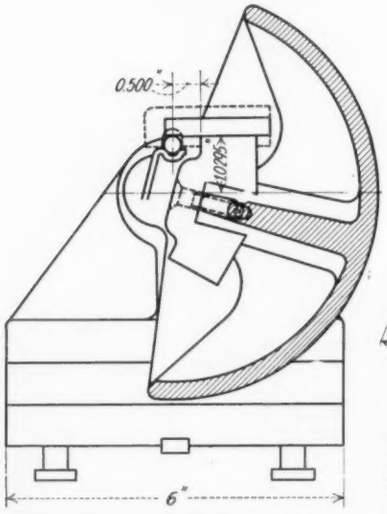


AFTER PLATING, *the carriage ball races are ground in a special set-up*



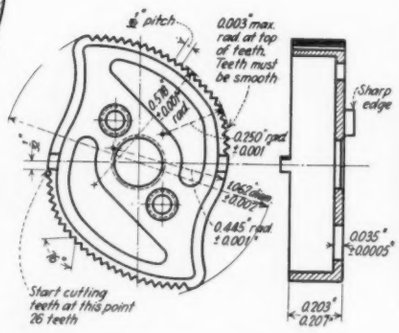
ESCAPEMENT PAWLS *are paired to within 0.0001 in. by means of an electric gage*

TYPE IS SOLDERED *to type bars electrically in a fixture that provides optical location of the letters*



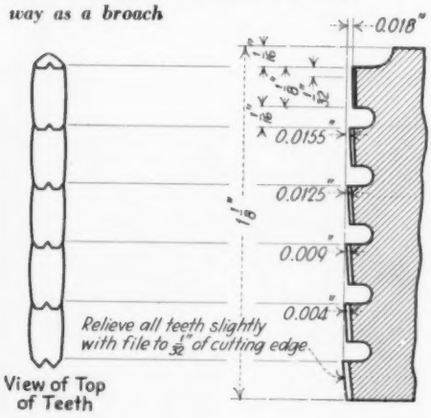
THIS FIXTURE LOCATES *the carriage from the ball race and turns over to permit grinding both sides of the work*

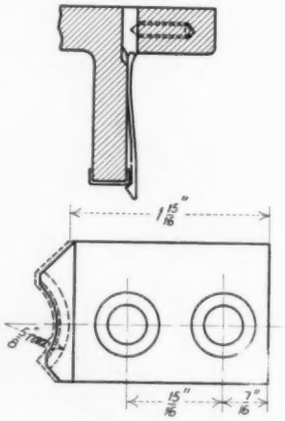
SMALL BUT COMPLETE, *the Rochester heat-treating department is capable of handling a wide variety of work*



LETTER CAM DIMENSIONS *must be held close since type bar operation depends on them*

A MULTIPLE PRESS TOOL *shaves the letter cam teeth in much the same way as a broach*





inch of metal, a fine finish and accurate spacing is insured. The cutting faces of the die are continually flushed out by oil under pressure which avoids any trouble from chips. A plate is arranged to swing over the die opening to prevent escape of the oil when the ram is in its upper position. The press on which this work is done is provided with a sweep guard which forces the operator's hand away from the work before the ram descends.

Still another part requiring close accuracy is the escapement pawl which feeds the carriage. These pawls are blanked and ground; they operate in pairs, and the important dimensions to be kept is the difference in height between the two pawls of each pair. This difference must

be 0.080 in., held to plus or minus 0.0001 in.

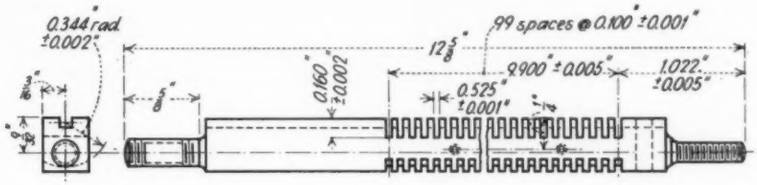
To sort the pawls to this accuracy a Sheffield electric gage is used. The gage is first set to standard size blocks, and each pawl, as it is measured, is classified according to the number of ten-thousandths it varies from standard. The pawls are placed in a series of compartments according to this classification where they are paired with mating pawls.

The carriage tabular rack is made of medium carbon steel which finishes to 3/8x7/15 in. The principal operation on this member is the slotting of the two sets of slots to an accuracy of plus or minus 0.001 in. For the standard carriage, there are 100 slots in both the top and bottom of this piece. Those on the top are 0.160 in. deep and square with the piece. Those on the bottom are circular with a 0.344 in. radius. Each set is cut on a milling machine in a single setup, using a gang of mills which cuts all the teeth in one pass. The circular slots are cut with the work mounted on a swiveling fixture which is hand-operated through a worm and wormwheel.

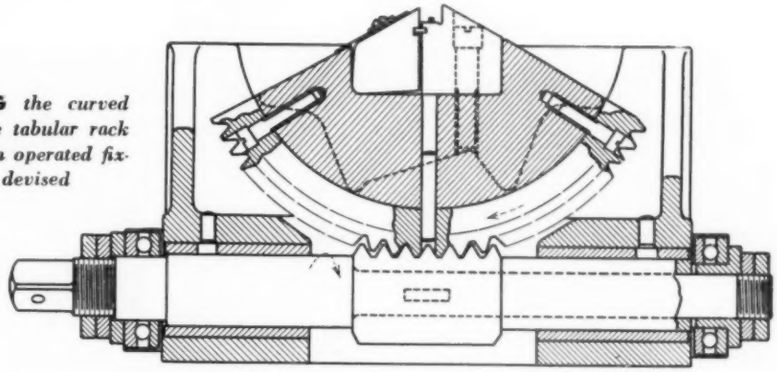
OPTICAL ASSEMBLY

The work of soldering the type to the type bars requires great care, since upon the precision of this operation depends the alignment of the work performed on these machines. The type bars are first mounted in the bar segment and are then placed on a fixture in which each bar may be brought down in turn to contact its corresponding piece of type. The type is held above a lens and illuminated which casts its image downward to a mirror which reflects it upon a ground glass screen directly in front of the operator. The screen is divided into two sections, one for capitals and one for lower-case letters. The ground glass is ruled into squares which determine the exact location of each piece of type. When the operator has correctly located the type, he operates an electric circuit which supplies the heat for soldering. This arrangement provides quick and precise assembly of the type to the type bar.

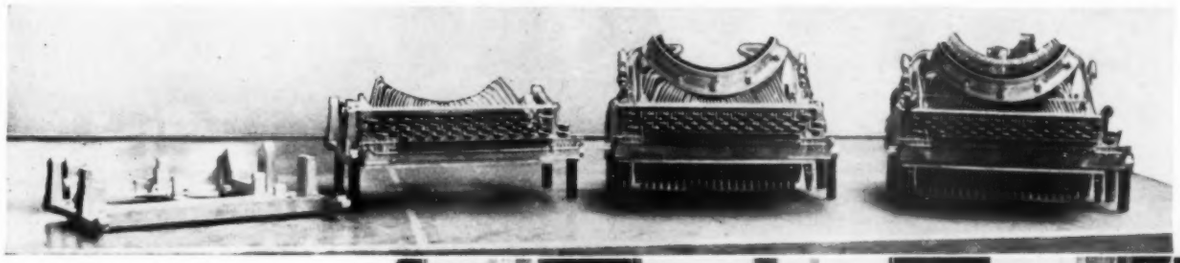
In addition to the machining and



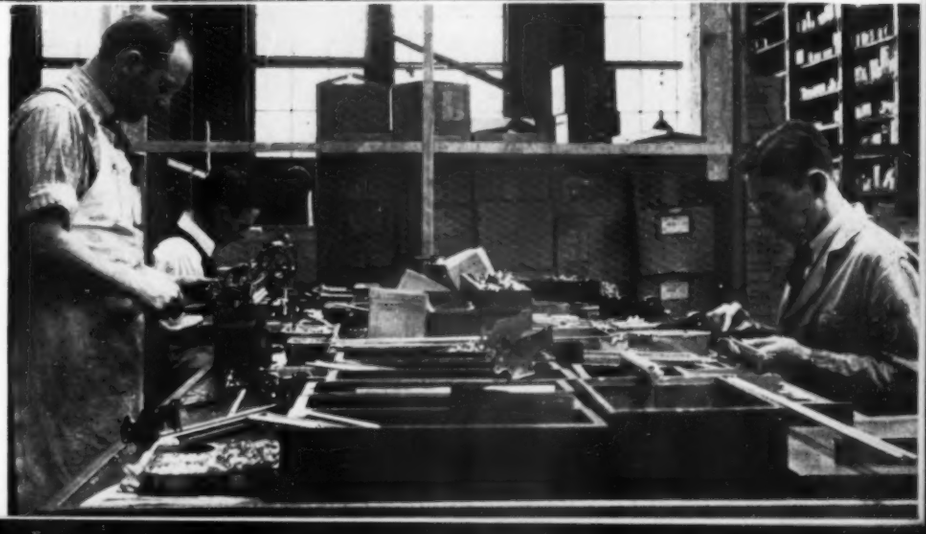
STRAIGHT GROOVES *are milled on one side of the tabular rack and curved grooves on the other*



FOR MILLING *the curved grooves in the tabular rack a special worm operated fixture has been devised*

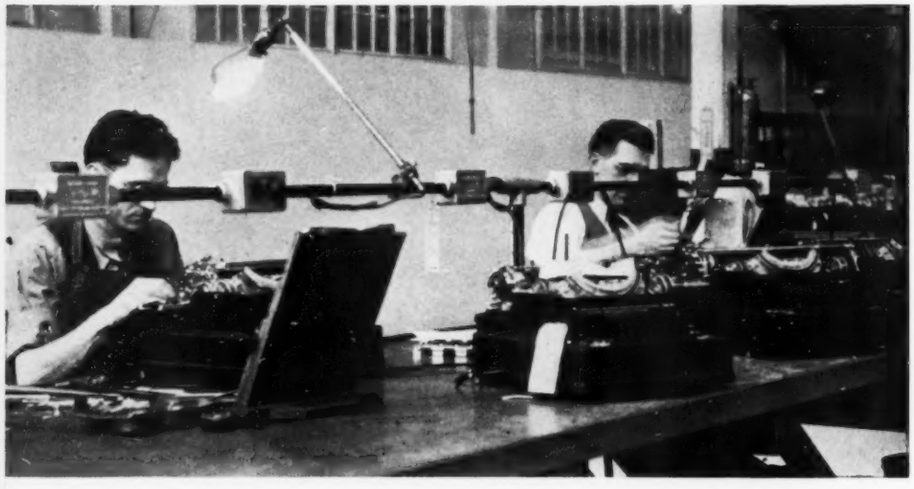


FOUR STAGES *in the machine frame assembly show how this unit is built up on a die cast main member*



CARRIAGES *are constructed on a job assembly bench that feeds into the main line*

PROGRESSIVE METHODS *are used in the assembly line which includes inspection*



FINAL TOUCHES *are added as the writing machines pass along the alignment bench*

press department, the Electric Writing Machine division has its own heat-treatment and plating departments. Such parts as type bars and bell cranks are made of spring steel which is given the desirable degree of toughness by heating to about 1500 F. and quenching in oil. A Hayes electric resistance furnace, having a gas curtain to prevent oxidation of the work, is used for operations of this kind. This furnace is equipped with Leeds & Northrup automatic temperature control. It is also used for carburizing and for annealing the few cast-iron parts which go into the machine, such as the type bar segments, in order to age them and make for easy machining. Other small parts such as links, the type itself, the spacing rack, the feed pawls, nuts, screws and rivets are case hardened by boiling in cyanide. One or two parts which must be hardened at the ends only, such as the key levers, are heated by means of an acetylene torch. This department is also provided with an electric tempering bath; a Rockwell hardness tester is used to inspect the correctness of the heat-treatment.

Before plating, small parts are placed in a tumbling barrel to remove burrs. For this purpose two tumbling barrels are used: one wet, and the other dry, according to the nature of the work. The parts then pass through a Blakesley vapor-type degreaser before entering the plating room. At this plant, tanks are provided for copper, nickel, chromium and cadmium plating. In addition there is an electric cleaning bath. All baths are of the batch type, and the work is placed in them on racks. Carriage parts are chromium plated with preliminary undercoats of copper and nickel. Cadmium plating is used as a rust-preventive for such small parts as type bars and key levers. Very small parts are tumble-plated in a barrel provided for that purpose. After plating such parts are polished in a burnishing barrel. Larger parts are buffed and polished by hand in accordance with standard practice.

Assembly practice on the electric writing machine is simplified by the design which enables most of the work to be done in sub-assemblies before it is mounted in the base. Each machine has 163 sub-assemblies containing a total of 2,521 parts. The general set-up is to have a main line assembly bench along which the work travels progressively from one operation to the other. The bench is supplied with sub-assemblies by transverse benches, feeding into it at the proper points.

OPERATING UNIT SEPARATE

The main operating unit of the machine is called the machine frame. When this assembly is completed it is mounted into the base by fitting two slots in the frame over two accurately located pins in the base. The frame is then swung upward and secured in place by four screws. The design is simple and permits removal of the operating mechanism at any time with little effort.

As in the Endicott plant, both process and parts inspection are used at Rochester. Inspectors work right in the main assembly line checking the progress of the work at each stage.

After the assembly all functions are checked and then the machines go to a special aligning bench for final alignment. Aligning inspection is followed by a complete final inspection and then a writing test. The units are then ready for shipment with the assurance that every care has been taken to insure their satisfactory performance.

Pullmans moved into Republic's Chicago Works as sleeping quarters

Why Independent Steel Producers Refuse to Sign Labor Contracts

Republic, Inland and Youngstown Sheet & Tube convinced that contract with C.I.O. leads directly to closed shop and check-off....Point out that such contracts have not prevented automobile strikes

STRANGE THINGS are happening in the present steel strike which extends over a far-flung front from Chicago to Buffalo and centers in the famed Mahoning Valley of Ohio. The strike was called by the Steel Workers Organizing Committee not because Republic Steel, Youngstown Sheet & Tube and Inland Steel refused to practice collective bargaining, not because they have not been paying high wages, not because hours of employment have been too long and not because working conditions were bad, but solely because the three companies stand adamant in their unwillingness to put their names on S.W.O.C. written contracts.

To the casual reader it may appear that the companies have chosen to quibble over a technicality. If they are willing to do all the things that a contract calls for, why not sign on the dotted line? Well, the managements think that the situation isn't so simple as that.

The real reason why the companies gag on the contract pill is that they are opposed to the C.C.C. Those three letters may mean Civilian Conservation Corps to some people, but to the executives of the strike-bound companies they spell Contract, Closed Shop and Check-off. Hardly will the ink be dry on a union contract before the union will come along with a formal request for a closed shop, they feel. After the closed shop has been fastened on management, the check-off is but a step farther. John L. Lewis's strength in the coal industry has sprung from the financial security of the check-off which provides the United Mine Workers with its funds. What reason is there to believe that his goal in other industries isn't the check-off?

Let's see exactly where Republic and Sheet & Tube stand, as disclosed by their official pronouncements. Both companies emphasize that they always have fulfilled all labor obligations without signing an agreement. They point out that it is not customary in human or business relations to require parties to state in writing that they will obey the law because that fact is assumed. Moreover, a contract creates an artificial need for union officials to negotiate a new agreement every year, thereby subjecting the company to the risk of periodic shutdowns if the two parties don't agree.

Written labor contracts, they say, are not flexible. They usually apply for a twelve-months' period without changes. Under such a contract workers would not have secured the three steel wage increases which they got in 1933 and the two granted since last November 1.

A still more potent argument, believe the companies, is the fact obvious to any newspaper reader that signed contracts with labor unions have not brought industrial peace. Take General Motors as a shining example. It signed an agreement with the United Automobile Workers on February 11 of this year. Since then there have been 80-odd strikes in G. M. factories, showing that the union leaders signing agreements on behalf of labor haven't the power to enforce them.

There is another slant on the situation, according to the companies. The National Labor Relations Act was not established in order to give bargaining for labor into the hands of one authority, the Committee for Industrial Organization. Says Sheet & Tube's letter to employees, "It was not intended that such single authority should be enabled to set up a power over all American industry."

Sheet & Tube goes on to say that "the signed agreement demanded of us could not be enforced by us because it would be a one-sided instrument whereunder the employer alone would possess legal responsibility." If precedent means anything, a signed contract usually is used by the union to coerce and intimidate employees into joining.

So much for the position taken by the companies. As to the difficulties run into by both Republic and Sheet & Tube during the strike, that is another story. One interesting chapter has been the attitude of the post office department in delivering mail to strike-bound mills. Attempts to ship in food to Republic workers at Warren, Ohio, by parcel post have been futile because the postmaster has refused to accept "irregular" packages. The postmaster there indicated clearly that strike leaders had been permitted to examine packages and decide whether or not they should be delivered.

Tactics familiar to those who have gone through labor crises in Akron and in Michigan have been used in the Mahoning Valley. Pickets are moved about from one plant to another and from one company to another. Many of them are strangers to the townsfolk. They have been armed with baseball bats and clubs. They have diverted traffic from public highways at will. In Youngstown they issued passes to cars and pedestrians to cross a public bridge spanning part of the Republic plant there.

The story of the election at Canton, Ohio, seat of Republic's mills, is enlightening. Workers were to vote at city hall on whether they wished to return to their jobs. When voting time arrived, the city building was picketed by union men, some of them having come from Akron, thus preventing the election. Later the Canton Chamber of Commerce launched a secret mail ballot on the back-to-work question. Some 6500 ballots were printed on special watermarked paper with identification marks that could not be duplicated. Though they were mailed first class, it took twelve hours for these ballots to get out of the Canton post office. Meanwhile S.W.O.C. ran an ad in the local paper advising employees to boycott the vote. According to the story, 3800 genuine ballots came back with an overwhelming vote for a return to work. At the same time about 2500 phoney ballots, all marked against resumption of operations, were received by the committee of clergymen who supervised the election.

Canton also was the scene of the distribution of union handbills to strikers saying that union leaders were getting government relief for them and that four government agencies were fighting on their side. The same statement was issued as an ultimatum to workers still in the plants, and they were given twelve hours to come out and join up.

The back-to-work movement has been given further impetus by the vote at the Newton Steel Division of Republic Steel at Monroe, Mich. It was conducted by the mayor with the use of the regular election machinery of the city. About 70 per cent of eligible employees voted. When asked, "Are you in favor of the strike?", 30 answered yes and 782 no. 856 voted their desire to return to work, with only 20 recording a negative vote.

Republic Steel, and also Sheet & Tube, has insisted that its company police refrain from use of firearms unless they are bodily attacked. That rule has been strictly observed. The riot at South Chicago was outside of Republic Steel's property and no company police were involved. There is said to be nothing to the charge that Republic has spent one million dollars for arms and ammunition for its various plants. When asked about expenditures of steel companies for firearms, one prominent executive who should know said, "I don't suppose the entire steel industry ever spent a million dollars for guns and ammunition in any 25 years of its life."

As to the attitude of stockholders, a large number of letters have poured into both Republic and Sheet & Tube offices in support of their positions. In contrast Republic has received only five letters criticizing its stand, Sheet & Tube none. The suit filed against Republic for an accounting of its expenditures for arms and ammunition is believed to be a union "frame-up." The stockholder bought ten shares of stock on a Tuesday and filed the suit on Thursday. Investigation is reported to have revealed him to be a C.I.O. organizer at Toledo, Ohio.

Now that the Newspaper Guild has gone whole hog for the C.I.O. union leaders in the steel strike have passed word up the picket lines in the Mahoning Valley to treat newspaper boys "nice because they are now in our ranks." With such a situation existing, one might wonder how the steel companies can expect to get a fair shake in the newspaper accounts of the strike.

Automobile blockade in front of plant gate

Detroit LETTER

Combat "quickie" sitdowns with closed plants . . . Union makes no effort to prevent wild-cat strikes, makes new demands on General Motors . . . Ford workers organize loyalty group . . . Overdrive a feature of new cars

Detroit, June 14.—To offer competition to the C.I.O., The Workers Council for Social Justice, Incorporated has been formed with headquarters in Dearborn. All officers except one are Ford employees. The organization expects to enroll 50,000 Ford workers. Initiation fee is 25 cents and dues are 25 cents a month. Aims are to work for a living annual wage, to secure a just share in the profits of production for the workers, to reduce interest rates on loans to 1½ percent, to provide home ownership or lower rents for workers, to secure lower prices for food and clothing, to establish mutual savings banks for workers savings, to work for unionization of labor on a Christian and not a destructive basis. Public opinion in Michigan has reacted violently against the C.I.O. since the Lansing holiday, the Saginaw Valley Power strike and the recent epidemic of "Quickie" sitdowns. The strong stand taken by officials and citizens of Monroe in the past week is believed to have marked a turning point.

DETROIT—The labor uproar in which southern Michigan has been embroiled the past week has overshadowed all other happenings. There are indications that long-suffering John Q. Public, as well as industry, is getting pretty well fed up with the chaotic conditions resulting from the U.A.W.'s recent actions. Some of the automotive plants have decided the only thing to do is to shut up shop entirely when "quickie" sitdowns happen.

U.A.W. Must Meet Pledge

Having been subjected to the disrupting effects of some 80-odd strikes since Feb. 11 in its plants, General Motors is considering a drastic procedure. The U.A.W. has made certain demands on the corporation for changes in its present contract beginning Aug. 11. General Motors officials have been leaning toward a policy of saying to the U.A.W. that no changes will be discussed until the union can demonstrate its ability to live up to its pledged word.

The U.A.W. has talked loudly about its intention to discipline severely those responsible for wild-cat strikes, but actually its national officers have done nothing to prevent them. This has led to a story circulated in Detroit stating that union officials themselves connive at such strikes to whip up the flagging interest of the rank and file. One local newspaper repeated this story in its editorial column and proceeded to challenge union leaders to disprove it.

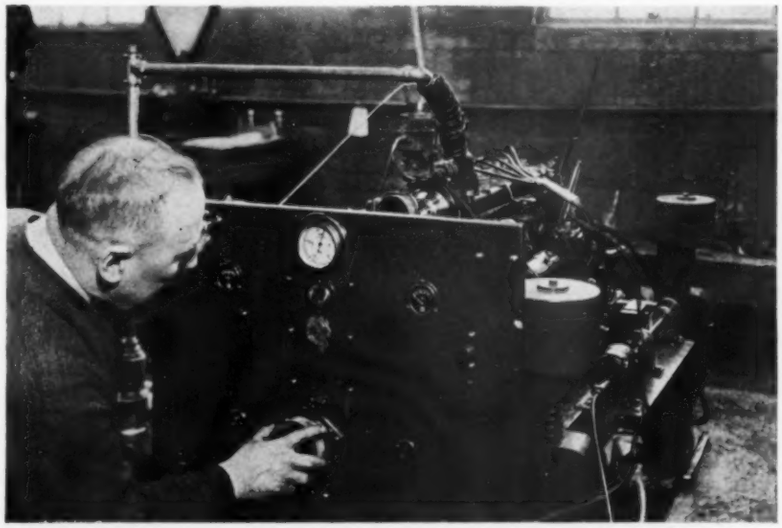
Fresh demands to be made on General Motors by U.A.W. are as follows: (a) sole bargaining rights in all plants; (b) a 35-hour week and seven-hour day; (c) national minimum wages of 75 cents for women and 85 cents for men; (d) straight seniority with a 15-day trial period instead of the present six-months' period for new employees; (e) 10 per cent bonus for workers on afternoon and night shifts; (f) employment preference in any new plant to be given workers laid off by shutdowns in other cities, thus preventing moving a plant to avoid the union; (g) indefinite extension of the present contract with 30-days' notice for termination or revision instead of 60 days as now required.

Temporarily the spotlight is off Mr. Ford, probably because the U.A.W. has its hands full elsewhere.

Ford's Backlog

Ford has been producing as many cars as possible all year to build up ample dealers' stocks in case it might be faced with a strike. This accounts for the fact that Rouge is down to four days a week now. The reduction in operations has nothing to do with institution of a 32-hour week by Mr. Ford, as some newspapers have inferred. The story is going around among Ford workers that if Mr. Ford should be pushed into a tight spot by the union, he may announce a partnership with his employees whereby they would get a substantial slice of the company's profits, as well as other benefits.

Ford's decision not to make any important changes in '38 models is believed partly linked with the un-



***Engine Balance*—Possibility of unbalanced engines going undetected into Chrysler cars has become more remote with the adoption of the balance-checking instrument. It indicates the amount of static and dynamic unbalance and the external counterweighting required to correct any excessive unbalance**

certain labor situation. The U.A.W. appears to have in the back of its head a plan for tying up Ford operations at the beginning of next season's production and until the labor atmosphere at Rouge is clarified, Ford is likely to proceed cautiously with equipment purchases. Orders are being placed for machinery for Ford's French plant. A total of 75 to 100 machines will be bought.

Equipment programs in anticipation of '38 models have about been completed and no sizable buying is looked for until fall, unless Ford should come through with unexpected orders. Pontiac is to spend shortly close to $100,000 for machinery for an apprentice training school to be erected at Pontiac, Mich. A final decision has not been made as to whether the new addition to Fisher's plant 1 at Flint will contain a die shop, despite the fact that G.M.'s announcement mentioned such a shop. No inquiries for big machines for a die shop have been made.

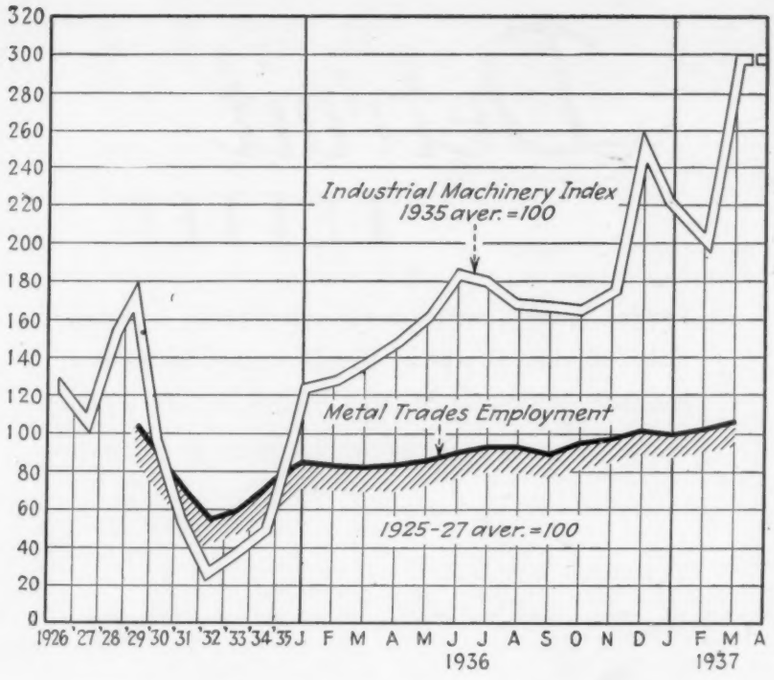
New Models Coming

Buick in 1938 will have the distinction of being the first car maker in volume production to have independent springing on all four wheels. Stout's Scarab is the only American car so equipped thus far. A minimum of redesign is necessary by Buick for this change because of its use of the torque tube drive.

This week the automotive press is to see the new '38 Hupmobile models. Hupp will have them on the market probably in July. Packard will have its new lines out in September with few changes from current models. All Packards will have the steel top next year. Overdrives will be a feature of most cars next year. Twelve companies now are offering it as standard or optional equipment. Ford has approved the Columbia two-speed overdrive axle for optional factory installation on Lincoln-Zephyrs and Ford V-eights.

Chrome-plated steel parts may be in for some stiff competition if American car makers adopt a method used for more than a year in Australia. For such parts as door handles and knobs, a coating of Tenite (plastic molding) 0.015 in. thick is pressed into place over a die cast core. This coating needs no polishing and its color matches that of the car. General Motors is experimenting.

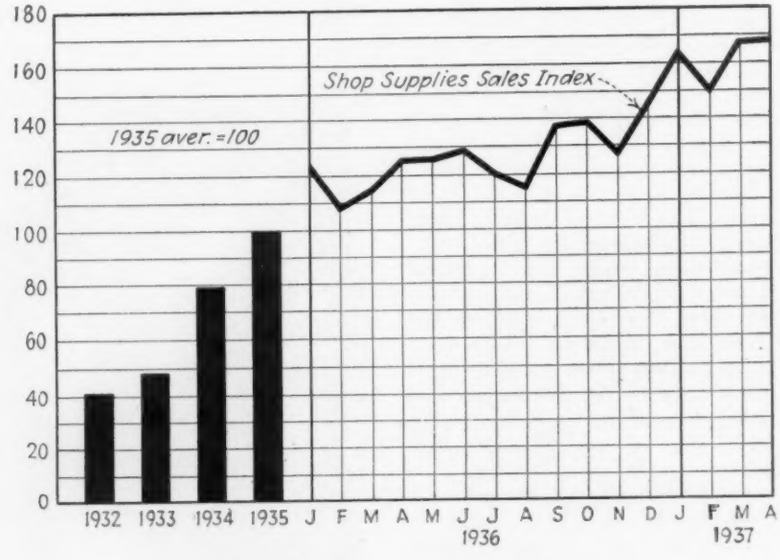
Next year stainless steel will be used more than ever before, particularly for radiator grilles. The only stainless grille at present is Hudson's. Stainless as exterior trim also will be employed more extensively.



Industrial Machinery Index Maintains High Level

When the final reports were received our March index of industrial machinery sales climbed to a new high level. Instead of being slightly below the December peak, as in the preliminary estimate, it was 40 points above it. The April figure, with one factor missing, is also at the 300 level, but it may slip back a few points when the missing factor is included.

The Labor Barometer of the National Metal Trades Association is now definitely above the 1925-27 basic average. It stood at 106.7 in March.



Shop Supplies Sales Index Climbs Higher

A further rise in the index of shop supplies sales shows that the March rise was no accident. It has reached a new high of 168.4.

WATCHING Washington

N.A.M. representatives oppose wage-hour bill . . . Johnson and Hormel testify for it . . . John Lewis seeks amendment to keep unions in saddle . . . Miss Perkins against imports provision

WASHINGTON—Until four representatives of the National Association of Manufacturers appeared before the joint Congressional committee on the Black-Connery Labor Standards Bill, June 10, practically all the testimony had been favorable to the bill. Indeed it had previously been said that the witness list was a set-up for the bill, that the opposition would not be heard. A more likely explanation is that industrialists were not responding to invitations, figuring that the committee is 100 per cent pro-labor anyway and that it would report favorably in any case.

Against Industry Interference

N.A.M. witnesses were James A. Emery, the association's general counsel, Noel Sargent, its economist, L. N. Bent, vice-president of the Hercules Powder Co. and chairman of the association's employment relations committee, and Robert B. Dresser, lawyer, who is acting chairman of its committee on relation of government to industry. During the course of their testimony these representatives of N.A.M. declared themselves favorable to the basic objectives of the bill but classed the proposed legislation as drafted as unconstitutional, too inclusive, ambiguous, cumbersome and a violation of economic law which would raise prices to the consumer. They argued that the objectives of the bill could best be attained by allowing American industry to work out its salvation without governmental interference. They pointed out that in 25 manufacturing industries the average work week is 41 hours as against 48.3 in 1929, average hourly earnings are 11.6 per cent higher than in April, 1936, and 15.9 per cent higher than in 1929. Rather than a legislative "straight jacket" for industry Mr. Emery pleaded for protection from "labor combinations in the field of commerce."

The Congressional committee's temper was reflected in its questions and replies. Industry's spokesmen were told that some kind of wage and hour regulation was coming and that they should make the best of it in helping to draft the legislation.

At the bill's first hearing, Robert Jackson, assistant attorney general, was the only witness. From the first he appeared to be not only selling but explaining the bill to Connery and Black and the joint committee. At no time did these two seem to assume a position as its authors. Jackson denied similarity between the Labor Standards bill and NIRA, and contended that the former is constitutional.

Industry's position on the bill is weakened by a divided front. Contrasting with the stand taken by N.A.M. was the testimony of Robert Johnson, president of Johnson & Johnson, who claimed to have successful results with a six-hour day.

Although there was a joker in his contentions, Mr. Johnson's testimony made a tremendous impression. The joker is that J. & J. are their own customers for their three textile mills and do not need to make a profit on them; they can obtain their earnings from the sick room supplies made from the cotton goods.

Hormel Offers Suggestions

But the remarks of Jay C. Hormel, of the meat packing concern, are not open to this criticism. Against undeniable competition, Hormel's minimum wage is nearly $25 for men and over $20 for women. Mr. Hormel offered four propositions for consideration in connection with the pending bill: that the American workman is entitled to the highest wage base rate the national economy will afford; no employer should be allowed to profit through sub-standard wages; security of tenure of employment should be provided; and, violent seasonal fluctuations in employment and employee earnings should be avoided.

Another willing witness was John L. Lewis, chairman of C.I.O. and president of the United Mine Workers. William Green, A.F. of L. head who testified previously, tried to forestall the government from taking labor leadership away from the unions by adding six amendments strengthening labor's bargaining power as against the Labor Standards Board which the Black-Connery bill would set up. Lewis sought to achieve the same end by urging that Section 5 of the bill be stricken out. Section 5 says that whenever the Board has reason to doubt the facilities for effective bargaining it shall conduct an investigation and, with its findings as a basis, issue an order setting up fair wages and hours. He contended that if Section 5 were left in it would bring the Labor Standards Board into conflict with the Wagner Board.

Secretary of Labor Perkins testified for the bill but rejected Connery's proposal by regulating imports. She contended that the buying power of labor would be increased to such an extent that imports could be absorbed in addition to domestic production. In fact Connery got little support from any of the witnesses for his import provision, the only point in which his version differs from that of Senator Black.

Arbitration Ahead

It appears almost certain that if union labor in general, and C.I.O. in particular, continues to win ground in every skirmish, resulting eventually in a closed shop country, it will also win something which no labor leader wants—compulsory arbitration of labor disputes, with government officials as the referees.

High New Deal officials admit privately that WHEN the collective bargaining cause is completely victorious THEN the government must take the responsibility for arbitrating decisions. It is not coming quickly—it may not come for several years. But the feeling, even among strongly pro-labor New Dealers, is that someone simply must be supreme, and this someone must have political responsibility—be responsive to the public. Until labor has won the present campaign, new dealers say, the government should be on the side of labor in every scrap—and this includes use of the mails.—CARTER FIELD, *Washington Bureau, McGraw-Hill Publishing Co.*

Mechanical Group, A.A.R. Meets in Atlantic City

The Association of American Railroads, Mechanical Division, meets in Atlantic City Auditorium, June 16-23. This meeting is being held in conjunction with the exhibit of the Railway Supply Manufacturers Association.

The morning sessions will be addressed by J. W. Burnett, general superintendent motive power and machinery, Union Pacific Railway; W. H. Winterrowd, vice-president, Franklin Railway Supply Co., Inc., on "Research and Locomotive Development"; L. K. Sillcox, first vice-president, New York Air Brake Company, on "What Next in Car Equipment?" Committees will report on various equipment and material projects.

The afternoon sessions have been set aside for the inspection of the exhibits.

Index of Machine Tool Orders

Based on Volume of Shipments for 1926

Month	Index of Orders: Domestic	Foreign	Total	3 Months' Average Index	% Foreign to Total Orders
1936 — June	106.5	22.3	128.8	124.4	17
July	104.4	45.7	150.1	132.6	30
August	96.1	31.4	127.5	135.5	24
September	82.9	35.6	118.5	132.0	30
October	105.4	31.1	136.5	127.5	23
November	110.7	36.4	147.1	134.0	25
December	205.7	52.0	257.7	180.4	20
1937 — January	156.1	44.0	200.3	201.7	22
February	122.4	42.8	165.2	207.7	26
March	172.1	39.5	211.6	192.4	18
April	232.5	50.0	282.5	219.8	18
May	161.4	47.1	208.5	234.2	22

Industrial Review

• NEW YORK, JUNE 15.—Interruption of production by strikes, threats of strikes and shortage of materials due to labor troubles cannot help but leave its imprint on the machinery industry. This imprint is now noticeable in a downward trend of machinery orders from the peak reached in April. Machine tool builders are busy in their large backlogs, and some of them would welcome the respite to shorten deliveries were it not for the shadow of labor agitation in their own shops. The third quarter will apparently fall below the levels set in the first two. The stimulus of price advances having past, buyers have become apprehensive and have returned to a hand-to-mouth policy. The maintenance of a comparatively good volume of sales reflects a basic need of better machinery despite these adverse influences.

• NEW ENGLAND found May disappointing with hoped-for orders failing to materialize. Inquiries continue to come in fast, and there is a possibility that lost ground may be recovered. In the New York area, June shows a slight slackening, but inquiries here, too, are active. The railroads display more signs of interest in new equipment. April was the top in Philadelphia, with May and June scoring successive declines.

• PITTSBURGH orders and inquiries are slipping with little prospect of pick-up until the labor situation has changed for the better. In some cases, supply business is hampered by shortage of stock caused by labor difficulties of the suppliers. May sales in Cincinnati were below those for April, and June will show a further decline. Strikes are few here but agitation is plentiful. Employees of the Heckman Can Co. have voted in favor of the C.I.O. union. Falling volume of business is a direct result of strikes in Cleveland. There is considerable inquiry on new projects in Toledo, but strikes are a potent influence in holding back buying.

• DETROIT SALES are mostly standard equipment for replacement. The small tool business shows a seasonal drop-off. Strikes have affected some orders in Chicago, but business has held up satisfactorily. June sales may equal those of May in this city. Milwaukee reports orders and inquiries coming in in good volume. In Indianapolis June is falling behind the previous three months. St. Louis is doing about the same as in May, but this is below the first quarter and April. Business is good on the Pacific Coast. The Douglas Aircraft Co. was awarded the largest peacetime naval aircraft contract for 177 bombers at $11,652,000.

47 Years With Landis

J. E. FRANTZ

Landis Tool Holds 40th Anniversary Celebration

The Landis Tool Company celebrated the 40th anniversary of its incorporation on May 29. At the same time tribute was paid to J. Elmer Frantz, president of the board of directors, who has been with the company not only since its incorporation in 1897, but also seven years prior to that time.

In a morning meeting Mr. Frantz spoke to the assembled employees concerning the events leading to the formation of the company and then briefly outlined its development to the present day. In the early eighties, F. F. Landis and Abram Landis, two brothers, designed and built a small universal grinder which included provision for a large volume of coolant during the grinding operation. In 1889 they organized a partnership known as Landis Bros. for the purpose of manufacturing various types of grinders. Mr. Frantz joined the organization in 1890. After complete destruction of the plant by fire in 1897, new capital was raised, the company was incorporated, plant rebuilt and manufacturing operations proceeded again.

Six men of the 63 employed at the time of incorporation are still on the payroll of the company. Eighty of the present employees have been connected with the company for 25 years or more. Comparing the average wage rate of today with that which existed in 1897, there has been an increase of about 350 per cent.

The celebration was closed with a luncheon attended by representatives of numerous machine tool manufacturers, and by the officials and employees of the company.

T. W. Carlisle, President, Strong, Carlisle & Hammond

Tyler W. Carlisle, formerly vice-president, is now president, Strong, Carlisle & Hammond Co., Cleveland, machinery and mill supply dealers. He succeeds the late Herbert W. Strong. L. J. Hammond has returned to take an active part in the affairs of the company as chairman of the board after ten years retirement. George J. Zimmerman is now vice-president in charge of machinery sales. J. A. Stevens, and R. L. Keech, were re-elected treasurer and secretary, respectively.

New Officers Elected by Briggs Manufacturing

Walter P. Brown has been elected president, Briggs Mfg. Co., Detroit, to succeed W. O. Briggs who continues as chairman of the board. W. Dean Robinson was elected vice-president and appointed assistant general manager. E. E. Lundberg, formerly chief engineer, becomes vice-president in charge of engineering. S. J. Kennedy becomes vice-president in charge of manufacturing. He was formerly manager of the Detroit plant. A. D. Blackwood, comptroller, was made assistant secretary and assistant treasurer.

E. H. Hooker, New Chairman Industrial Conference Board

Elon H. Hooker, president, Hooker Electrochemical Co., was elected chairman of the National Industrial Conference Board at its 21st annual meeting held in New York. Dr. Virgil Jordan continues as president. Those elected as vice-chairmen were Irenee du Pont, director, E. I. du Pont de Nemours & Company; E. Kent Hubbard, president, Manufacturers Association of Connecticut; Walter J. Kohler, chairman, Kohler Co.; W. Gibson Carey, Jr., president, Yale & Towne Mfg Co.

Those elected to the executive committee are: Philip E. Bliss, president, The Warner & Swasey Co.; Wm. C. Dickerman, president, American Locomotive Co.; R. J. Hamilton, president, American Radiator Co.; Auguste G. Pratt, president, The Babcock & Wilcox Co.; A. W. Robertson, chairman, Westinghouse Electric & Mfg. Co.; Malcolm B. Stone, president, Ludlow Manufacturing Associates.

Among those elected councillors were: E. G. Grace, president, Bethlehem Steel Co.; C. F. Kelley, president, Anaconda Copper Mining Co.; G. M. Verity, chairman, American Rolling Mill Co.; and O. D. Young, chairman, General Electric Co.

Over 500 leaders in industrial, commercial, financial and professional life attended this meeting which was devoted to the consideration of "The Influence of Public Opinion and Education upon Economic Progress in America."

A.I.E.E. Announces Plans for 1937 Summer Convention

Ralph E. Flanders, president, Jones & Lamson Machine Co., will address the 1937 summer convention of the American Institute of Electrical Engineers on the subject of "The Engineer in a Changing World." The convention will be held at the Hotel Schroeder, Milwaukee, June 21-25. At the opening session, Dr. Frank

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GIVES YOU THESE 4 HEAT-TREATING ADVANTAGES

Design and production engineers find unexpected opportunities for product improvement and cost reduction in these characteristics of the Chapmanizing process for surface-hardening steels:

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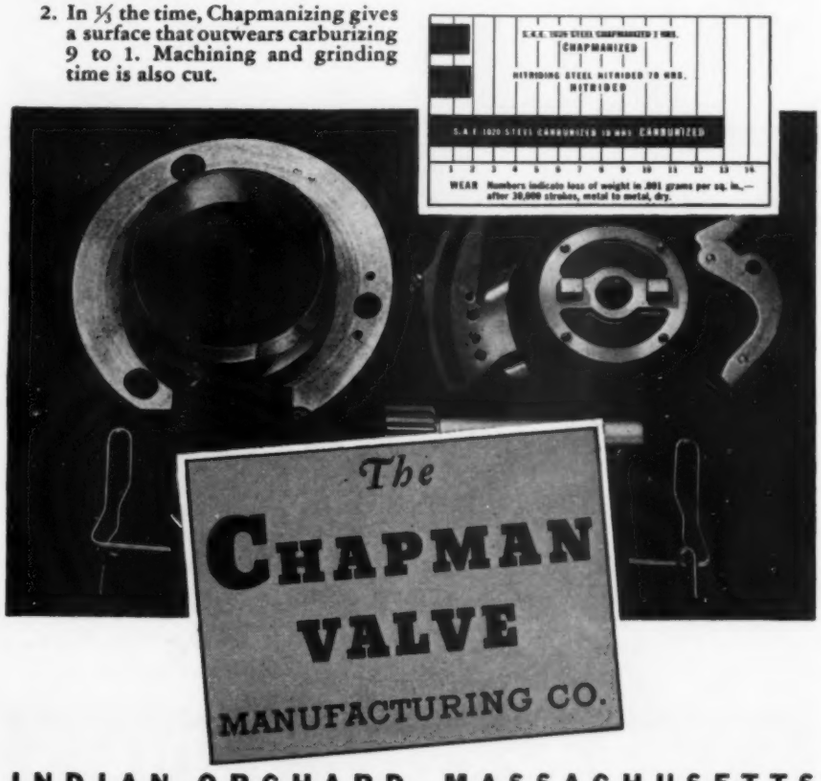
4. No capital investment. Use your present set-up . . . install the Chapmanizing Unit on a contract basis.

Send for new illustrated book containing complete engineering information.



INDIAN ORCHARD, MASSACHUSETTS

At the opening session, Dr. Frank Conrad, Westinghouse Electric & Mfg. Co., will receive the Lamme Medal, and prizes for papers will be given.

Among the papers scheduled for the technical program are "A C Motor Protection," by C. W. Kuhn, Cutler-Hammer, Inc.; "Coincidental Electric Drives" by L. E. Miller, Reliance Electric & Engineering Co.; "A New Approach to the Industrial Lighting Problem; Specific Lighting for Different Services" by H. B. Dates, Case School of Applied Science; Demonstration Address; "New Light Sources, Their Characteristics and Applications" by D. W. Atwater, Westinghouse Lamp Co.

The Friday morning, June 25, session on vibration and balance will be addressed by C. D. Greentree, General Electric Co., on "Vibration Measuring Instruments; Fundamental Consideration in Their Design"; O. E. Esval and C. A. Frische, Sperry Gyroscope Co., Inc., on "Dynamic Balancing of Small Gyroscope Rotors"; L. H. Hansel, The Felters Co., Inc., on "The Vibration Isolation of Machinery"; J. J. Ryan, University of Minnesota, will show motion pictures on mechanics of vibration.

Farm Equipment Leads in 1936 Machinery Sales

Farm equipment machines, with a total production of $487,273,428, led the increase in machinery sales for 1936, according to figures made public by the Bureau of Census. This represented an increase of 46 per cent over the 1935 figures and 127 per cent over the 1931 total. Tractors continued to hold the lead that they have had for some years, accounting for more than 43 per cent of the year's total, and an increase of almost 45 per cent over their 1935 total.

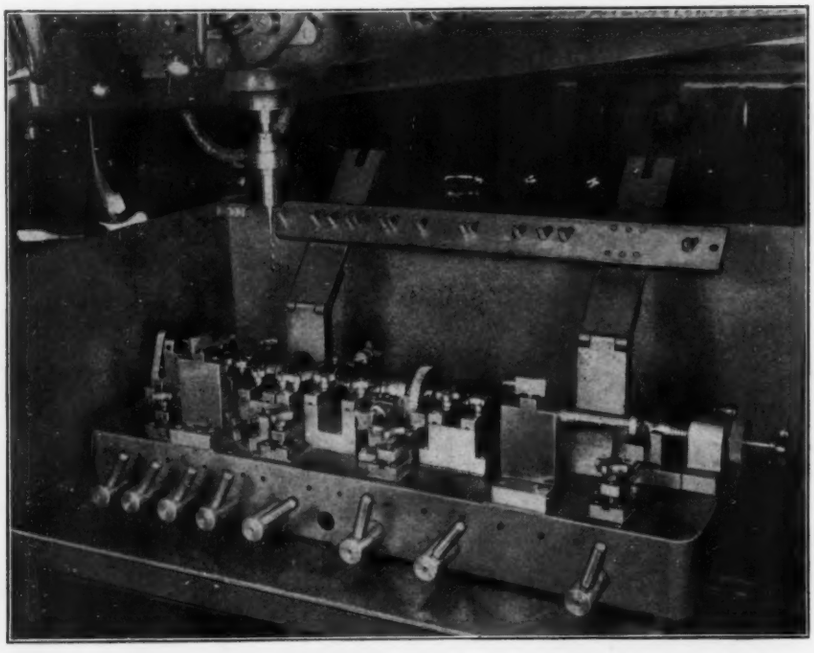
Figures for April exports of farm equipment indicate that substantial gain will be reported for the present year. Exports of farm implements and machinery from the United States during April were valued at $6,300,270, the highest monthly value recorded since April, 1931. This month's exports were 51 per cent greater than for April, 1936. Tractors represented 69 per cent of the total export with an increase of 50 per cent above the corresponding shipment in April 1936.

Machine Tool Imports Still Exceed Exports in England

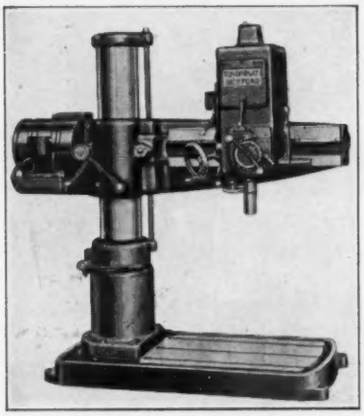
Great Britain imported £2,083,126 worth of machine tools in the first four months of the current year. This is more than twice the rate of import for 1936. At the same time, the decline in the value of the machine tools sold abroad continues. £596,945 worth of machinery were exported in the first four months of the current year as compared with £659,259 in the same period of 1936.

The United States still leads in the value of tools imported to the amount of £1,272,549. Germany comes next with a value of £486,720.

The primary reason for the drop in exports may be found when considering that the Soviet Union purchased £180,927 of machinery in the first four months of 1936 and only £7,442 in the same period in 1937. This drop completely wiped out the gains made in other countries.



At International Business Machines Corp.



For complete details of 3' and 4' Arm, 9" Dia. Column, High-Speed All-Geared Super-Service Radials, write for Bulletin R-21A.

There are many small holes to be drilled and taper reamed accurately and quickly in the cams and gears of this alphabet printers shaft. It is just the kind of a job where the centralized finger tip control of the Super-Service Radial shows up in substantial cost savings on every part handled. A range of spindle speeds to cover every type of work, including 3/32" and 1/8" drills, controlled by a single lever at the head. Fast tapping without driving clutches. Feather-light control of accurately balanced head and arm.

The Cincinnati Bickford Tool Company
Oakley, Cincinnati, Ohio, U. S. A.

SUPER-SERVICE RADIALS

Machine Progress Shown at Nagoya Exhibition

Tokyo—Heavy industries, particularly the machinery manufacturing industry, are an outstanding feature of the Nagoya Pan-Pacific Peace Exhibition which is being held under the auspices of the Nagoya municipality in celebration of the 30th anniversary of the opening of the port to foreign trade. Products of the 32 countries bordering the Pacific Coast with the exception of the United States are on display.

Five leading Japanese machine tool makers occupy a hall of their own. The Tokyo Gas & Electric Industry Company is exhibiting a car-wheel lathe, which has a swing over bed of 1,400 mm. The Okuma Iron Works is exhibiting high speed radial drills, a high speed 2,600 mm. universal lathe and a universal boring machine with Tungalloy cutters.

The Japanese army is placing overseas orders for aircraft manufacturing machinery. The first orders for the current fiscal year is 300 units for the Osaka arsenal.

Czechoslovakia is securing orders for machine tools by virtue of its low prices and the fact that they are said to be more prompt with deliveries.

According to the Finance Ministry, exports of Japanese machinery have increased 71 per cent in the first quarter of 1937 over the corresponding period of 1936. Imports in the same period have increased 38 per cent. A particular increase was noted in the export of metal and woodworking tools.

The Industry Promotion Museum of Tokyo is sponsoring a machinery show in Shanghai for five days, beginning June 22. A similar show was held in Tientsin last year.

A new company is being formed by Katsura Research Station for the manufacture of precision machinery for aircraft production. Headquarters and plant will be constructed in Tokyo.

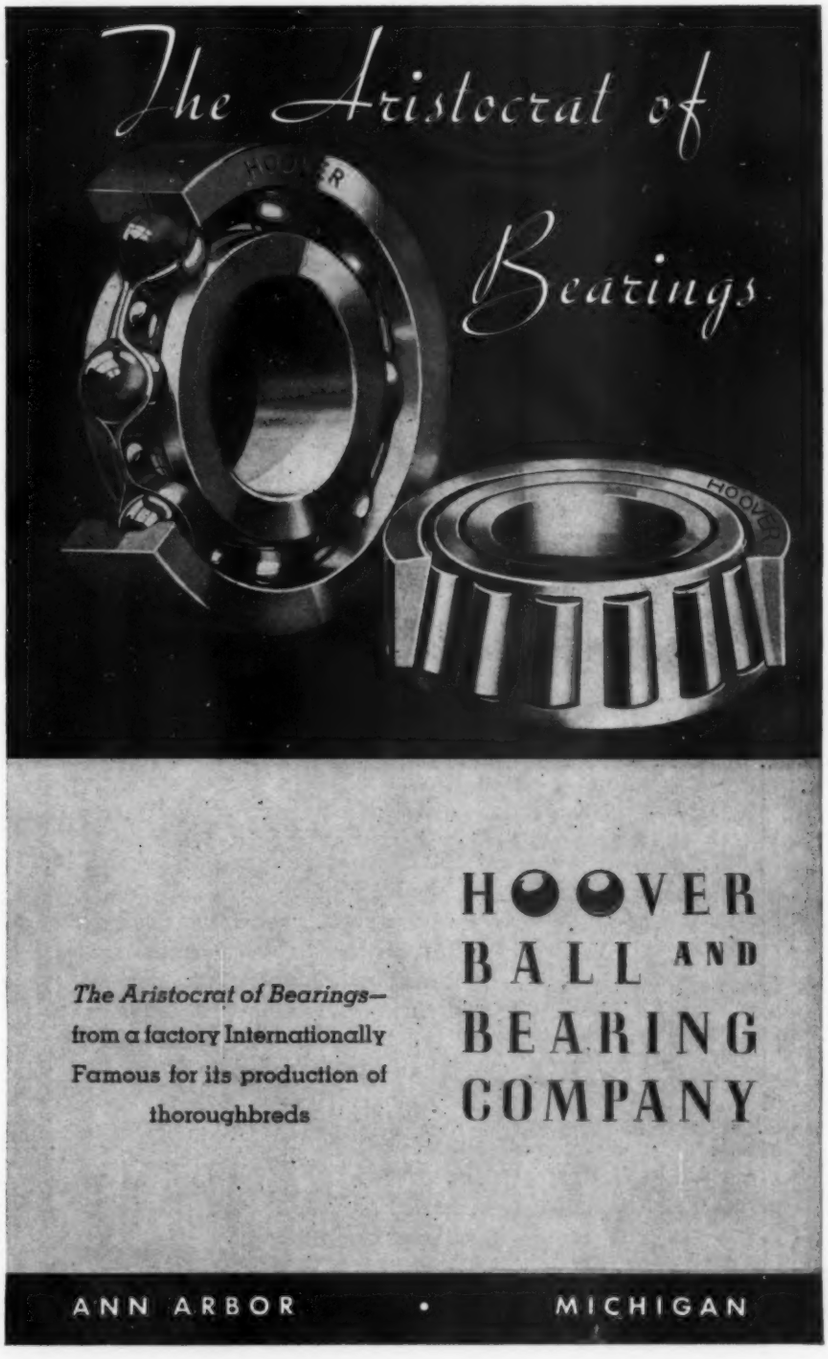
Standards for Dust Control Equipment Almost Complete

Standards of dust control practice are rapidly nearing completion by the Engineering Committee of the Dust Control Equipment Association, according to Arthur A. Tuscany, executive secretary.

At a meeting of the Association held June 9 at Cleveland, and attended by manufacturers of dust-control equipment, a discussion on the standard method of determining dust counts was held. Theo. Hatch, associate dust-control engineer, Division of Industrial Hygiene, Department of Labor, State of New York, spoke on the subject "Importance of Modern Standards and Methods of Dust Analysis upon Design and Efficiency of Dust Control Equipment."

The association has arranged for representation of its engineering committee on the American Foundrymen's Association Safety and Hygiene Committee, and on the Air Hygiene Foundation, and has requested representation on the American Standards Association Committee, Z-9, which committee is giving attention to the development of fundamentals relating to the design of exhaust systems.

The Air Hygiene Foundation is now preparing a plan of research to combat industrial diseases due to dust.



Industrialists Give New Stevens Institute Buildings

The cornerstones of two new dormitories, Palmer Hall and Jacobus Hall, were laid June 12 after the completion of the sixty-fifth annual commencement exercises of Stevens Institute of Technology. Palmer Hall was donated by Edgar Palmer, chairman of the board, New Jersey Zinc Co. William S. Barstow, long a leader in the development of public utilities, presented Jacobus Hall in honor of Dr. David S. Jacobus, Stevens '84, who was for many years professor of mechanical engineering on the Stevens faculty, and is now head of the engineering department of the Babcock & Wilcox Co. The new buildings will furnish a social center for the campus and will house 97 men. Some of the rooms will be reserved for men of limited means and certain dormitory scholarships will also be provided, according to Dr. Harvey N. Davis, president.

3,000 BLOWS
a Minute
40 HOURS
Without
REDRESSING

MOIL points used for breaking concrete with pneumatic hammers take a beating.

Shank breakage and the need for frequent redressing are common troubles.

The Jessop Steel Company, cooperating with the Brunner and Lay Company, a Chicago tool maker, was successful in producing moil points made of Jessop Shock-Proof Steel which stood up for 38 to 40 hours without redressing. Other points often required redressing after four or five hours on the same jobs. Shank breakage was virtually eliminated.

MAKERS OF
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91 Per Cent National Metal Show Space Taken

Ninety-one per cent of the exhibit space available for the 19th annual National Metal Show to be held in the Atlantic City Auditorium, Oct. 18-22, has already been contracted for by 189 industrial companies, according to W. H. Eisenman, managing director. Mr. Eisenman announces that only 31 exhibit spaces remain with the opening date five months away.

The National Metal Congress, held in conjunction with the Metal Show convenes on the second floor of the Auditorium. Five societies cooperate in this event, Iron and Steel and Institute of Metals Divisions of the American Institute of Mining and Metallurgical Engineers, the American Welding Society, American Society of Mechanical Engineers and the Wire Association, in addition to the American Society for Metals.

New Machinery Plants Aid Construction Boom

Industrial construction awards continue near the levels set during the first four months of this year, and there is no decrease in the inquiries for new plant, factory office or research facilities according to George A. Bryant, Jr., executive vice-president, The Austin Co. The wide range of new construction activity is interpreted as the soundest evidence of basic recovery.

Manufacturers of industrial equipment, including cranes, electric trucks and machine tools have been a source of much aditional construction. Volume of new construction for tool and die shops and allied industries in the Detroit area continues to climb.

U. S. Exports of Hardware Reach New High in April

Exports of hardware and allied products from the United States in April, 1937, with a value of $4,485,039 increased 51 per cent over exports of April, 1936, and approximately 10 per cent over shipments for March, 1937, according to preliminary figures compiled by the Metals and Minerals Division, Bureau of Foreign & Domestic Commerce.

Substantial gains were noted in exports of all classes of hardware, particularly hand tools, which increased from $941,637 in April, 1936, to $1,378,549 in April, 1937.

Joins N. Y. U. Faculty

Nation-Wide

LEON P. ALFORD

Leon P. Alford Joins N. Y. University Staff

Dr. Leon Pratt Alford, engineer-editor, is to succeed Joseph Wickham Roe as professor of administrative engineering and chairman of the department of industrial engineering, College of Engineering, New York University. Mr. Roe is retiring as professor-emeritus after sixteen years of teaching and administrative service.

Dr. Alford holds the Admiral Melville gold medal for contributions to the literature of mechanical engineering and the Gantt Memorial gold medal for distinguished achievement in industrial management. He was formerly editor of "American Machinist", "Industrial Management", and other publications. He later became vice-president of the Ronald Press.

E. E. Dreese Clarifies Rules on Lincoln Arc Welding Awards

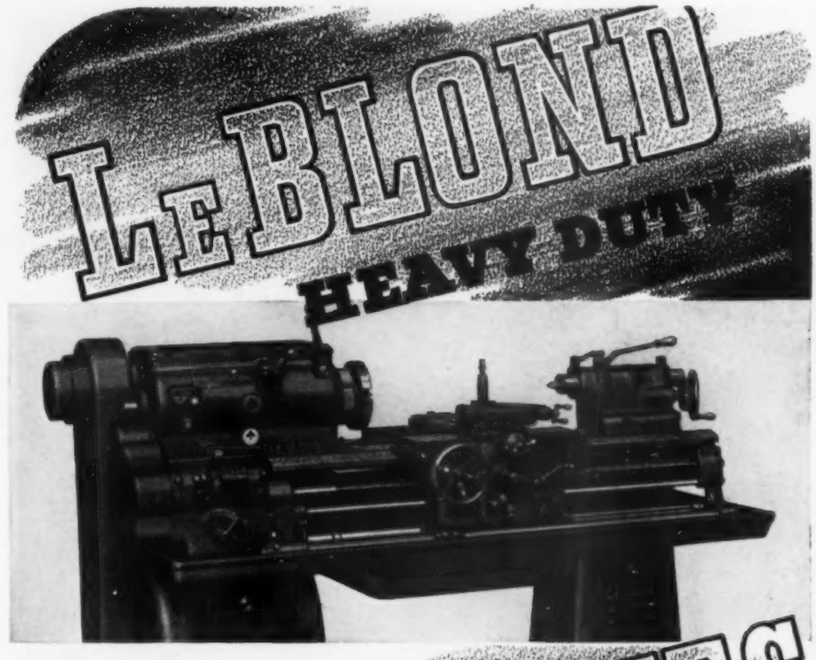
Dr. E. E. Dreese, chairman of the board of trustees and of the jury of awards, The James F. Lincoln Arc Welding Foundation, Cleveland, issued a statement further clarifying the object of the Foundation's 54 awards, totaling $25,300, for functional machinery papers in its $200,000 series of awards.

"The idea is entirely erroneous, as expressed in letters and reports from the machinery field, that the opportunities of the Lincoln Foundation's Functional Machinery Awards are available only to individuals familiar with electric welding and its use. The primary object of the fund is to encourage study of the machines built by some other method so that electric welding may be used in construction. The machine need not be built entirely by arc welding."

Dr. Dreese believes that ample time has been allowed in the award program to permit engineers to acquire sufficient knowledge of the principles of arc welded construction to allow them to compete.

Policy and Technology Institute at Purdue

As a part of its annual summer session, Purdue University will hold an Institute on American Policy and Technology from June 21-July 10. The institute will be devoted to lectures, discussions, and conferences on American policies and the effect of technological and related forces upon these policies.



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In the massive tailstock a full length bearing is provided for the spindle equal to the maximum overhang. Handwheel placed at convenient angle. Movement is through a worm and worm gear with thrust of worm against ball bearing. Tailstock spindle hollow with same diameter hole as head spindle. These are but a few of the superiorities of the LeBlond tailstock.

For almost a half century LeBlond Heavy Duty Lathes have been accepted as the standard of excellence. Constant improvement in design and operation, the incorporation of every new development, have maintained LeBlond leadership and given industry lathes that are unmatched in performance, unequaled in value.

You will find it to your profitable advantage to standardize on LeBlond . . . to enjoy the economies possible only with these superior lathes. Write for fully illustrated brochure.

The R. K. LeBLOND MACHINE TOOL CO., CINCINNATI, O.

20 North Wacker Drive, Chicago 103 Lafayette St., New York

Among those who will lecture at this Institute are Dr. A. A. Potter, dean of engineering, Purdue University, who will discuss the social significance of mechanical power and of industry; Dr. Owen D. Young, chairman of the board, General Electric Co., will discuss "The Science of Better Living;" Dr. Dexter S. Kimball, Dean of Engineering, Cornell University, will address several sessions of the Institute. Dr. Lillian M. Gilbreth, engineer and Purdue staff member, Amelia Earhart, Purdue staff member, Dr. Walter D. Pitkin, Columbia University, author and lecturer, David E. Ross, president, board of trustees, Purdue University, Colonel Frederick L. Devereux, authority in visual education, and others will address the various sessions of this Institute.

The regularly scheduled sessions end July 2.

LUFKIN INSIDE MICROMETER IS ACCURATE, EASY TO READ, EASY TO 'FEEL'

You'll get day-after-day satisfaction from the ingenious LUFKIN inside micrometer. It's just right in weight—you can get the "feel" most sensitively. It's just right in legibility—it's easy to read accurately. It's just right for any kind of inside measuring job—its precision never varies.

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PRECISION TOOLS
TAPES — RULES

SAGINAW, MICHIGAN • NEW YORK CITY

W. S. Davenport was Machine Tool Designer and Builder

William S. Davenport, president, Davenport Machine Tool Co., Inc., Rochester, N. Y., died last week at the age of 76.

Mr. Davenport spent twelve years with Brown & Sharpe Mfg. Co., Providence, R. I., where he designed an automatic screw machine which sold all over the world. He then went into business for himself designing special machinery for clock shops. During this time he designed the first multiple-spindle automatic screw machine which formed the basis of the company which he organized in 1919 and headed until the time of his death.

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Houdaille-Hersey Elects C. L. Barnes Chairman

Claire L. Barnes, formerly president, Houdaille-Hersey Corp., Detroit, is now chairman of the board, a newly created office. Charles Getler, formerly vice-president, was made president. Donald S. Devor, vice-president and general manager of the General Spring Bumper Corp., and a vice-president of the Oakes Products Corp., Detroit, is now vice-president along with Ralph S. Peo, vice-president and general manager, Houde Engineering Corp., Buffalo, another division of the Houdaille-Hersey Corp. Melville C. Mason was also elected vice-president.

•

GERALD KOCHENDERFER has been made sales manager, the National Tool Co., manufacturer of cutters, Cleveland, Ohio."

L. E. PECK, formerly sales manager, United States Tool Co., Ampere, N. J., is now manager of the press department, Thomas Spacing Machine Co., Pittsburgh.

S. M. WARNER has been made secretary, Timken-Detroit Axle Co., to succeed W. F. ROCKWELL who continues as vice-president.

J. S. WHYTE, formerly secretary and treasurer of the MacWhyte Co., Kenosha, Wis., wire rope manufacturers, was made president. He succeeds G. S. WHYTE who becomes chairman of the board.

CHARLES R. UNDERHILL is now president, Brown Fence & Wire Co., Cleveland. He succeeds the late FRANK SPITZ. M. B. SACKHEIM, formerly treasurer, has been elected vice-president.

Alvan Macauley Again Heads Auto Manufacturers

Alvan Macauley, president, Packard Motor Car Co., was re-elected president of the Automobile Manufacturers' Association at its annual meeting held in Detroit, June 3.

Alfred P. Sloan, Jr., chairman, General Motors Corp., was elected first vice-president. Wm. S. Knudsen, president, General Motors, was elected a director.

BUSINESS ITEMS

Aluminum Co. of America plans the construction of a new plant at Los Angeles, Calif., at a total cost of approximately $750,000 according to W. C. Lynch, manager, Los Angeles. The plant is expected to employ about 300 men.

International Harvester Co. will build a $4,000,000 plant and foundry in Indianapolis, according to SYDNEY G. MCALLISTER, president. It is expected that a total of 3,000 workers will be employed in the production of some 700 truck engines per day. Production is expected to start by February 1.

Frigidaire Division, General Motors Corp., will broaden its manufacturing and market activities in the near future by entering into the general appliance field with electric ranges and washers. Tools and dies will soon be ordered for installation in the Moraine City plant which is being enlarged and rearranged for the new products.

Harold E. Trent Co., manufacturers of electrically heated industrial equipment, Philadelphia, announce that its plant will be closed the week of July 5 for vacations. Emergency orders will be taken care of.

New Britain-Gridley Machine Division, The New Britain Machine Co., New Britain, Conn., has appointed J. J. BARRY as western representative with headquarters in Chicago.

Caldwell Well Screen Co., Inc., Fort Wayne, has been formed to manufacture well pumps and machinery. F. M. CALDWELL, S. M. WHITE and A. L. GOODALL are incorporators.

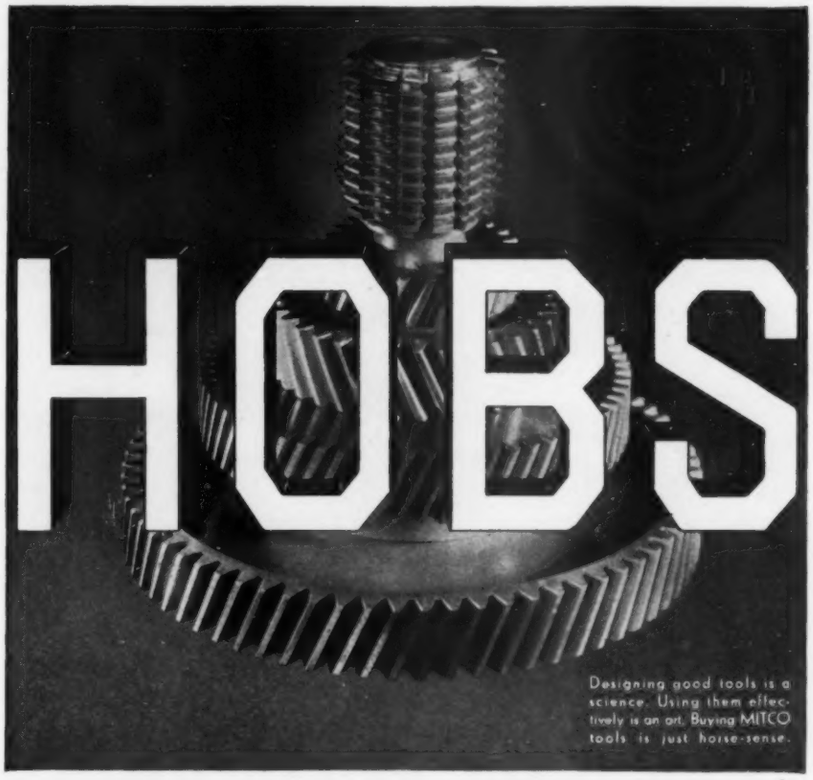
Warner & Swasey Co., Cleveland, announces its annual plant shutdown for vacations, Aug. 2–14. Only emergency repairs will be shipped.

Bryant Machinery & Engineering Co., 400 West Madison St., Chicago, has appointed Giebel Machine Tool Co., Inc., 236 W. 55th St., New York, as exclusive representative in the New York territory.

Westinghouse Electric & Mfg. Co., announce the opening of Pittsburgh Executive, Sales, and Lamp Division offices at 306 Fourth Ave.

Vultee Aircraft Division, Airplane Development Corp., 928 Cerritos Ave., Los Angeles, is erecting a new factory with an area of approximately 36,000 sq.ft.

G. A. WHITEHEAD, Philadelphia distributor, Owen clam shell buckets and grapples, has purchased the entire business of Maris Bros., Inc., Philadelphia, manufacturers of cranes and hoists. The new company is prepared to furnish parts for any Maris cranes now in service and will manufacture new cranes.



There are more MITCO hobs in use today than any other make. One reason is that Michigan Tool Company in addition to being the only major producer of every type of cutting tool is also a leading authority on gear production engineering. Only the finest steels, accurately ground by real craftsmen are used in Mitco hobs.

Why not let the MITCO representative in your territory quote on your hob and other tool requirements. Just wire or write:

MICHIGAN TOOL COMPANY

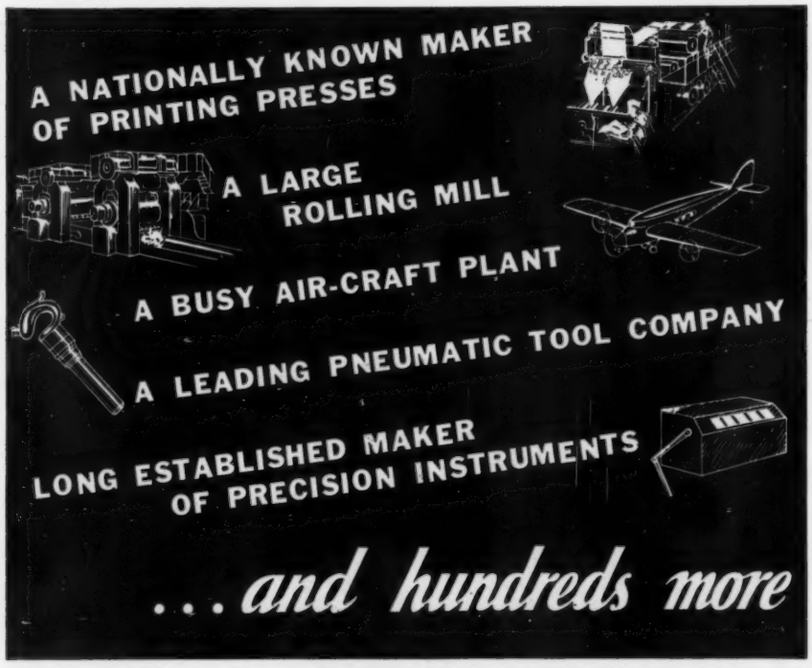
7171 E. McNichols Rd. **DETROIT, MICH.**

Harvey Machinery Co., is altering and adding to existing building and machinery plant at 62nd St. and Avalon Blvd., Los Angeles.

Federal Products Corp., manufacturers of precision measuring instruments, Providence, R. I., announce the addition of HENRY I. BOUCHARD at the Detroit office which is now at 7310 Woodward Ave. An office has been opened in Rochester, N. Y., 241 Powers Bldg., with ROBERT B. HAWKINS in charge.

Pioneer Engineering & Mfg. Co., 31 Melbourne Ave., Detroit, has appointed the Burklyn Machinery Co., Syracuse, N. Y., as general distributor in that city.

Cutler-Hammer, Inc., Milwaukee, has opened its new office at 1106 Central Tower, Youngstown, Ohio. E. J. GOVE will be in charge.


A NATIONALLY KNOWN MAKER OF PRINTING PRESSES
A LARGE ROLLING MILL
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A LEADING PNEUMATIC TOOL COMPANY
LONG ESTABLISHED MAKER OF PRECISION INSTRUMENTS
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1 It keeps work and tool clean
2 Helps prevent wheel loading or glazing
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4 Keeps wheel clean . . . free cutting
5 Assures more accurate work . . . better finish
6 Wheels require less frequent dressing

Whatever the nature of your business . . . wherever you do grinding, investigate the many advantages Oakite Grinding Compound can give you. Ask to have our nearby Service Man submit complete data and formulas for making up this time-tested, efficient grinding compound in your own plant. Write today.

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OAKITE PRODUCTS, INC., 24 Thames St., New York

Branch Offices and Representatives in All Principal Cities of the U. S.

Joseph . Monahan, engineer-agent, modern machine tools, Grand Rapids, Mich., has moved his office to 351 Indiana Ave., N. W.

Pennsylvania Pump & Compressor Co., Easton, Pa., has appointed the General Engineering Equipment Co., 578 Century Bldg., Indianapolis, Ind., as representatives in that district.

Revere Copper & Brass, Inc., has opened a new branch office at the Capital National Bank Bldg., 410 Asylum St., Hartford, Conn.

Phelps Dodge Copper Products Corp. will erect an addition to the plant of the Habirshaw Cable & Wire Division at Yonkers, N.Y., according to WYLIE BROWN, president.

General Controls Co., manufacturer of automatic temperature, pressure and flow controls for gas, oil, refrigeration and air conditioning, Glendale, Calif., has begun work on the construction of a new factory at a cost of $186,000 of which $100,000 will be spent for machinery and equipment.

Slaysman Co., machinists, 813 E. Pratt St., Baltimore, has been incorporated by RAY V. WATSON, WALTER O. DOELLER and ALEXANDER SMICK.

PERSONALS

R. W. GRIFFITH, works manager, Briggs & Stratton Corp., Milwaukee, has been made vice-president in charge of manufacturing.

FRANK F. WATTS, formerly chief engineer, Hupp Motor Car Corp., Detroit, is now vice-president and chief engineer.

J. D. MCLEOD is now vice-president and general manager, Copeland Refrigeration Corp., Detroit. He was formerly with the Chevrolet Motor Division, General Motors Corp.

DR. JOHN S. PLASKETT, C.B.E., F.R.S., until recently the head of the Dominion Astrophysical Observatory, Victoria, B. C., has been appointed scientific consultant on telescope design for The Warner & Swasey Co., Cleveland.

H. W. MONS, Hill-Clarke Machinery Co., Chicago, will sail on the *Queen Mary* next week to follow up with European shop owners a mailing of Hill-Clarke literature which was sent out recently.

KENNETH H. CONDIT, editor, *American Machinist*, has been appointed to serve as A.S.M.E. representative on the National Management Council, to fill the unexpired term of PROFESSOR J. W. ROE.

Promoted by G M.

E. B. NEWILL

E. B. NEWILL, chief engineer and director of research, Frigidaire Division, General Motors Corp., was promoted to assistant general manager. S. M. SCHWELLER, formerly assistant chief engineer, will succeed Mr. Newill. Mr. Newill also has been made assistant general manager of the Frigidaire and Delco-Frigidaire Conditioning Division of the General Motors Sales Corp.

HAROLD A. TODD has been elected president, Wisconsin Motor Corp., Milwaukee, to succeed H. W. SCHNETZKY, resigned.

EDWARD W. RISTAU was elected vice-president, Skilsaw, Inc., Chicago. He will continue his work of the past five years in directing sales, advertising and promotion.

A. L. SONNHALTER, formerly vice-president in charge of production, Pittsburgh Crucible Steel Co., Pittsburgh, is now president. He succeeds S. P. HUFNAGEL who will continue as chairman and president, Crucible Steel Co. of America, the parent organization. Mr. Sonnhalter has been with the firm since 1923.

PAUL H. SETZLER is production manager, Lukenweld, Inc. He was formerly development engineer for Lincoln Electric Co.

L. J. REAY has been made president, Mahr Mfg. Co., oil and gas burning equipment and furnaces, Minneapolis.

FREDRICK G. BANNING, formerly of Cornell University, is now chief engineer in charge of engineering development, Designers for Industry, Inc., Cleveland, industrial designers and product stylists. Mr. Banning will also supervise the mechanical and technical qualities of designs originating in the firm's New York and Chicago offices.

JAMES W. RYAN, works superintendent, Westinghouse Porcelain Plant, Emeryville, Calif., received the Silver Westinghouse Award of Merit in recognition of his distinguished service and executive ability, exhibited in managing the manufacturing activities of his plant. Mr. Ryan is the first employee to receive this award in the Pacific Coast district.

OBITUARIES

OTTO C. ROHDE, vice-president and chief engineer, Champion Spark Plug Co., died June 3 of injuries received at the Indianapolis Speedway. Mr. Rohde had suffered a fractured skull and other injuries when he was struck by a racing car which crashed into the pit at Indianapolis, May 28. Mr. Rohde was chairman of the ignition division of the S.A.E.

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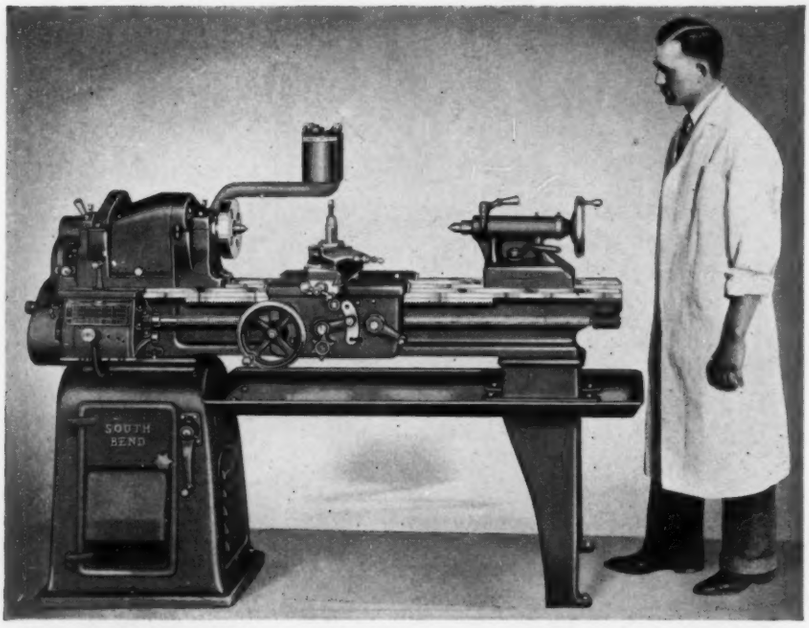
ARTHUR E. PIERCE, 47, for the past 25 years purchasing agent, Norton Co., Worcester, Mass., died June 8.

EDWIN WARD PUTNAM, president-treasurer, Pattern Model Co., Hartford, Conn., died May 29 at the age of 67. Mr. Putnam went to Hartford in 1893.

CHARLES H. GIFFORD, formerly vice-president and treasurer, American Blower Co., Detroit, and for a time general manager, B. F. Sturtevant Co., Boston, died May 27 at the age of 78.

KARL KENDIG, executive vice-president, National Tool Co., Cleveland, died May 21, at the age of 66. Mr. Kendig was also a former executive of the old Whitman-Barnes Co.

FENTON LAWSON, president, F. H. Lawson Co., sheet steel products, Cincinnati, died May 27 at the age of 80 years.



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J. R. Dunlap, Technical Editor and Publisher, Dies

John Robertson Dunlap, editor and publisher of numerous engineering books and technical magazines, died June 4 in New York City at the age of 80.

Mr. Dunlap was educated at Linsly Institute, Wheeling, W.Va., as a civil engineer. In 1889 he founded "The India Rubber World" in New York. The following year he started "Hardware" and later "The Engineering Magazine," "The Engineering Index," "Industrial Management," and "Industry Illustrated." He later became chairman of the board of the Engineering Magazine Co., which subsequently was absorbed by the McGraw-Hill Publishing Co.

MEETINGS

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Summer Convention. Milwaukee, Wis. June 21-25. H. H. HENLINE, secretary, 33 West 39th St., New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. National meeting of Applied Mechanics and Hydraulics Division. June 25–26. Cornell University, Ithaca, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting and exhibit of testing apparatus and related equipment. Waldorf-Astoria Hotel, New York. June 28-July 2. R. E. HESS, assistant secretary, 260 So. Broad St., Philadelphia.

ASSOCIATION OF AMERICAN RAILROADS, MECHANICAL DIVISION. Annual meeting, Municipal Auditorium, Atlantic City. June 16-23.

ECONOMICS CONFERENCE FOR ENGINEERS. Seventh Annual Convention. Stevens Engineering Camp, Johnsonburg, Warren County, N. J. June 18-26. PRESIDENT HARVEY N. DAVIS, Stevens Institute of Technology, Hoboken, N. J.

NATIONAL COACH TRAILER MANUFACTURERS' ASSOCIATION. Exhibit and meeting. Manistee, Mich. August 1-10. E. JUNGCLAS, secretary, 1719 Brackman Ave., Mount Washington, Cincinnati.

RAILWAY SUPPLY MANUFACTURERS ASSOCIATION. Exhibit and meeting in connection with Association of American Railroads, Mechanical Division. Municipal Auditorium, Atlantic City. June 16-23. J. D. CONWAY, secretary-treasurer, 1941 Oliver Bldg., Pittsburgh, Pa.

EXPORT OPPORTUNITIES

East Africa Timber Co-operative Society Ltd., P. O Box 86, Kenya, Nairobi, is in the market for several automatic machines for the manufacture of roofing shingles.

A. B. Greer Co., London, Ontario, is equipping a department for manufacture of transit homes and is interested in prices of equipment.

References concerning the following commission agents and importers can be obtained from the Business Publishers International Corporation, 330 West 42nd St., New York, N. Y.

H. E. Braisted & Co., Inc., 1265 B. Mitre, Buenos Aires, Argentina, S.A., has clients located in Argentina, Paraguay and Uruguay. Interested in the sale of industrial machinery and public works construction equipment.

Julio V. Hoffay, Casilla de Correo 2185, Buenos Aires, Argentina, S.A., is interested in industrial machinery.

Alfred G. A. Hoffman, P. O. Box 1339, Rio de Janeiro, Brazil, S.A., has sub-agents in the principal cities of Brazil and is interested in industrial machinery and power plant equipment.

Leopoldo Delgado Barreneche, Calle Sto. Domingo No. 17, Santa Marta, Colombia, S.A., operates principally along the Atlantic coast of Colombia and the Department of Magdalena. Interested in industrial machinery and public works construction equipment.

A. Castaneda, Calle de Tapia 1714 Pte., Monterrey, N.L., Mexico, machinery importer handling machine tools, sheet metal stamping and woodworking machinery, requests contact with manufacturers of iron or steel wheels of 32 in., 38 in., or 60 in. diameter and 10 in. wide, with axles 7 ft. between centers of wheels. Ten pairs of wheels are required, equipped with ball or roller bearings.

J. M. Chavez, Isabel La Catolica No. 14, Mexico, D.F., Mexico, desires to contact manufacturers of lathes and electric generators who are not represented in Mexico.

Enrique Gulke, Managua, Nicaragua, is interested in numerous accessories and items such as are used in machine shops, chemical and other industrial plants.

P. Mata Sifontes, Apartado 572, Caracas, Venezuela, S.A., expresses an interest in industrial machinery and hydraulic equipment.

* Interested American firms and individuals may obtain the names and addresses of the foreign firms making these inquiries upon application to the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, Washington, or any district or cooperative office. Please refer to key number.

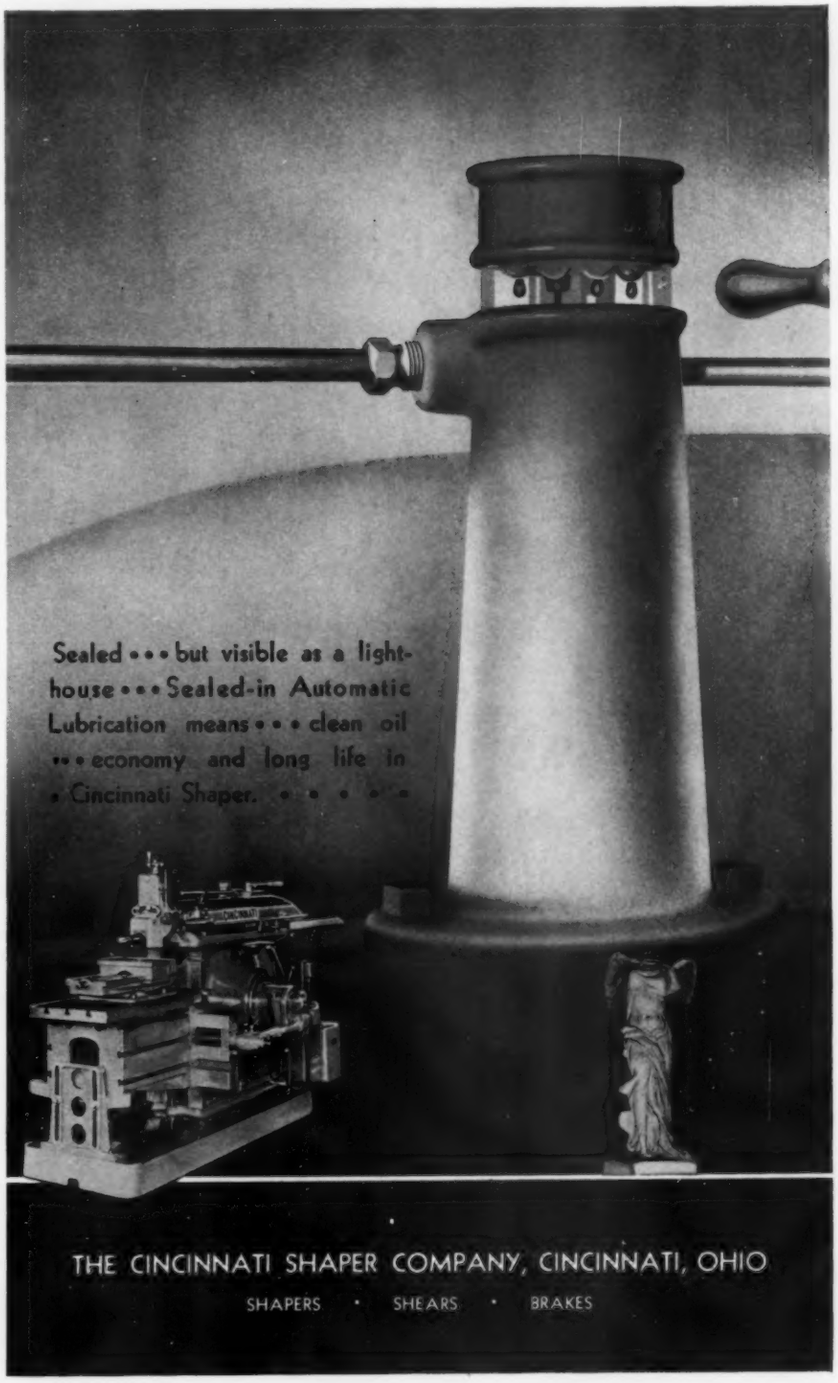
Air conditioning and ventilating equipment. (Agency.) London, England. *3300.

Coffee-roasting and grinding machines and equipment, and machines for making chocolate from cocoa beans. (Purchase.) Lima, Peru. *3328.

Metal-working machinery, and machine tools. (Agency or Purchase.) London, England. *3288.

Pumps, small, for operation by motor, ¾ up to 10 horsepower. (Agency.) Manila, P. I. *3289.

Pumps, turbine, deep-well. (Agency.) Habana, Cuba. *3301.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PATENTS

May 25, 1937

Metal Working Machinery

Milling Machine. Peter P-G Hall, Philadelphia, assigned to The Hall Planetary Co., Philadelphia. Patent 2,081,275.

Lathe. Frederick T. Potter, Whitinsville, Mass., assigned to Stark Tool Co., Waltham, Mass. Patent 2,081,641.

Parts and Mechanisms

Machine Tool (Spindle Headstock). Keith F. Gallimore and Garner H. Schurger, Fond du Lac, Wis., assigned to Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. Patent 2,081,145.

Machine Tool Transmission and Control. Joseph B. Armitage, Wauwatosa, Wis., assigned to Kearney & Trecker Corp., West Allis, Wis. Patent 2,081,288.

Boring Bar Attachment. Thomas Lane, Atlanta, Ga. Patent 2,081,487.

Method of and Apparatus for Face Milling. Raymond S. Perry and Alexander Oberhoffken, Rockford, Ill., assigned to The Ingersoll Milling Machine Co., Rockford. Patent 2,081,639.

Processes

Method and Material for Coating Metal. Robert R. Tanner, Highland Park, Mich., assigned to Metal Finishing Research Corp., Detroit. Patent 2,081,160.

Tools and Accessories

Center Punch. Percy B. Botting, Sr., Troup, Tex. Patent 2,081,217.

Rotary Face Bit. Frank E. Jarvis, The Dalles, Ore. Patent 2,081,302.

June 1, 1937

Metal Working Machinery

Milling Machine. Arthur F. Bennett, West Barrington, and August L. Krause, Providence, R. I., assigned to Brown & Sharpe Mfg. Co. Patent 2,082,140.

Oil Groove Cutting Device. Clair A. Nickles, Ponca City, Okla. Patent 2,082,212.

Grinding Machine. Wallace H. Wood and Carl G. Flygare, Worcester, Mass., assigned to Norton Co., Worcester. Patents, 2,082,727; 2,082,728.

Form Grinding Apparatus. Herbert J. Griffing and Carl G. Flygare, Worcester, Mass., assigned to Norton Co., Worcester. Patent 2,082,734.

Truing Apparatus for Lapping Machines. Herbert S. Indge, Westboro, Mass., assigned to Norton Co., Worcester. Patent 2,082,736.

Parts and Mechanisms

Multiple Spindle Drilling Machine Control. Hiram W. Fox, Austin A. Riddell, and Howard D. Corwin, Jackson, Mich., assigned to Fox Machine Co., Jackson. Patent 2,082,103.

Attachment for Drill Presses (Slotting). Clarence Turnespeed, Springfield, Ohio, assigned to Frank G. Campbell, Arlington County, Va. Patent 2,082,310.

Turning Attachment (Multiple Spindle Screw Machine). Harry W. Rupple, Shaker Heights, Ohio, assigned to The Cleveland Automatic Machine Co., Cleveland. Patent 2,082,516.

Honing Apparatus. Herbert S. Indge, Westboro, Mass., assigned to Norton Co., Worcester. Patent 2,082,737.

Die Head. Charles A. Reimschissel, Waynesboro, Pa., assigned to Landis Machine Co., Waynesboro. Patents 2,082,757; 2,082,758.

Processes

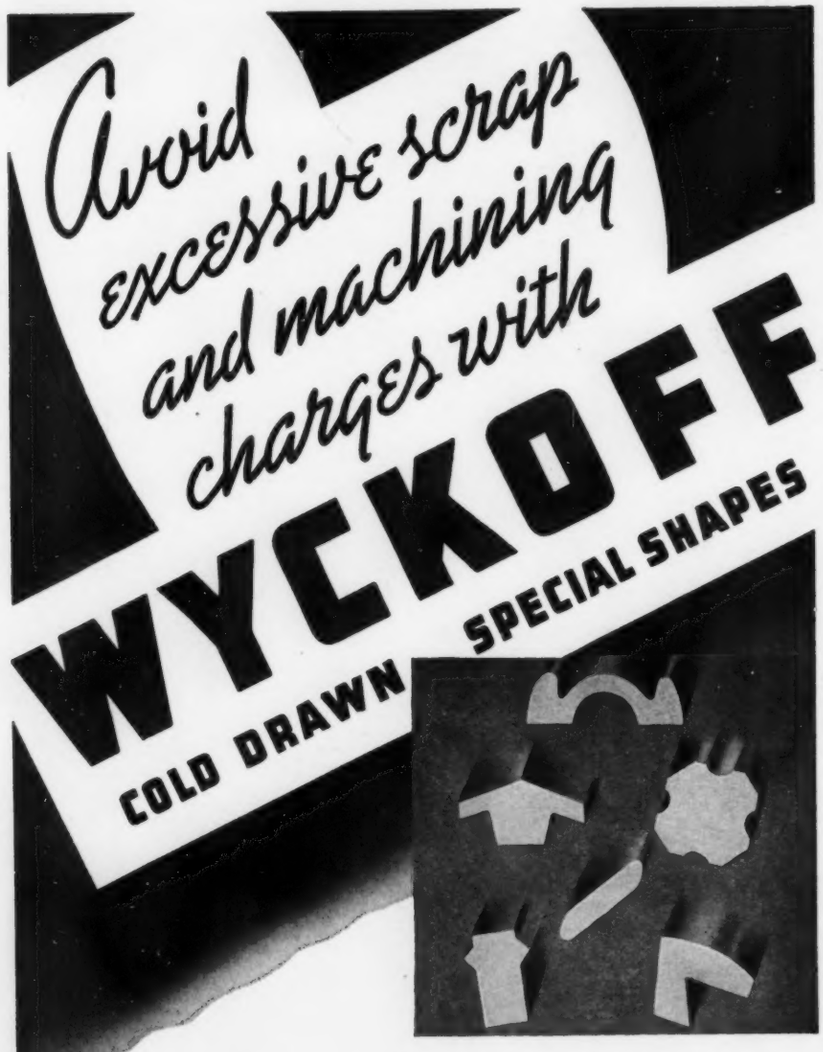
Process and Apparatus for Fusion Welding. James L. Anderson, Closter, N. J., assigned to Air Reduction Co., Inc., New York. Patent 2,081,897.

Press Fitting. Richard J. Brittain, Jr., Bloomfield, N. J., assigned to General Motors Corp., Detroit. Patent 2,082,379.

Tools and Accessories

Compression Riveting or Punching Device. George T. Harcourt, Detroit, assigned to Chicago Pneumatic Tool Co., New York. Patent 2,082,334.

Metal Bending Apparatus. Jesse E. Rawson, Cleveland. Patent 2,082,653.



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J. A. Harlan To Head Air Conditioning Group

J. A. Harlan, manager, commercial division, Nash-Kelvinator Corp., Detroit, was elected president of the Air Conditioning Manufacturers' Association at the annual meeting in Hot Springs, Va. Other officers elected were Wm. H. Price, Jr., vice-president, Carrier Corp., Newark, N. J., vice-president; P. A. McKittrick, general manager, Parks-Cramer Co., Fitchburg, Mass., treasurer.